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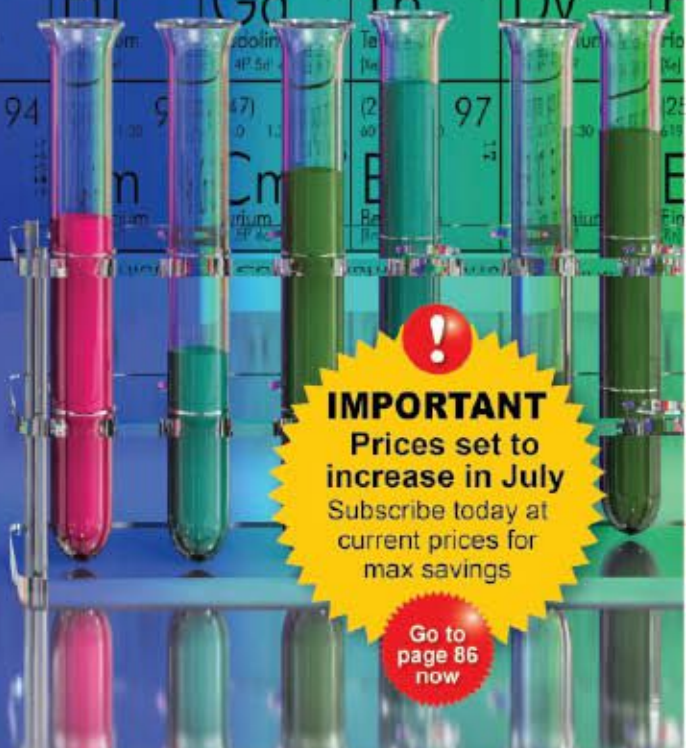

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CHEMISTRY today

Volume 27 No. 5 May 2018

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CONTENTS

TO OUR READERS

We are happy that intelligent students, teachers and other professionals continue to patronise Mathematics Today, Chemistry Today, Physics For You and Biology Today.

To them, we are addressing this open letter in view of increase in the cost of production and postage in the last seven years. All round spiralling prices have pushed production costs so high, that many in out fraternity find it impossible to continue business. We are compelled to raise the price to ₹ 40 from July 2018 issue.

We understand the pressure of cost on the student-teacher community in general but, we are hoping our readers will understand our problems and that we have no option but to comply with this unavoidable move.

We on our part, will keep up our efforts to improve the magazines in all its aspects.

Printed and Published by Mahabir Singh on behalf of MTG Learning Media Pvt. Ltd. Printed at HT Media Ltd., B-2, Sector-63, Noida, UP-201307 and published at 406, Taj Apartment, Ring Road, Near Safdarjung Hospital, New Delhi - 110029.
Editor : Anil Ahlawat

CHEMISTRY MUSING

PROBLEM SET 58

Chemistry Musing was started from August '13 issue of Chemistry Today. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / NEET / AIIMS / JIPMER with additional study material. In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / NEET. The detailed solutions of these problems will be published in next issue of Chemistry Today.
The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue. We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

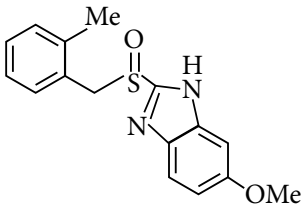
JEE MAIN/NEET

1. A Duma's bulb full of air weighs 22.567 g at 20°C and 755 mm pressure. Full of vapours of a substance at 120 °C and 755 mm pressure weighs 22.8617 g. The capacity of bulb is 200 mL. Find the molecular weight of substance. The density of air is 0.00129 g/mL.
(a) 22.32 (b) 28.90 (c) 86.64 (d) 98.14

2. Two moles of an ester (*A*) are condensed in presence of sodium ethoxide to give a β-keto ester (*B*) and ethanol. On heating in an acidic solution (*B*) gives ethanol and a β-keto acid (*C*). On decarboxylation (*C*) gives 3-pentanone. Identify *A*.
(a) $CH_3CH_2COOC_2H_5$ (b) $CH_3CH_2COOCH_3$
(c) $CH_3CH_2CH_2CH_2COOH$
(d) $CH_3COOC_2H_5$

3. BI_3 is a symmetrical planar molecule, all the B — I bonds lie at 120° of each other. The distance between the I atoms is 3.54Å. The radius of covalently bonded I atom is 1.33Å. The covalent radius of boron is
(a) 1.77Å (b) 2.04Å (c) 0.71Å (d) 1.33Å

4. How many carbon atoms have tetrahedral geometry in the given structure?

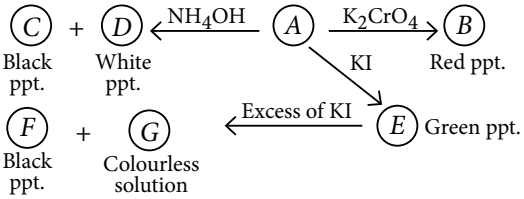


(a) 4
(b) 2
(c) 3 (d) 5

5. If for the cell, $Zn(s) + Cu^{2+}(aq) \rightleftharpoons Cu(s) + Zn^{2+}_{(aq)}$ entropy change $\Delta S°$ is 94.6 J K^{-1} mol^{-1}, then temperature coefficient of the e.m.f of a cell is
(a) 5×10^{-4} V K^{-1} (b) 1×10^{-3} V K^{-1}
(c) 4.9×10^{-4} V K^{-1} (d) 9.65×10^{-4} V K^{-1}

JEE ADVANCED

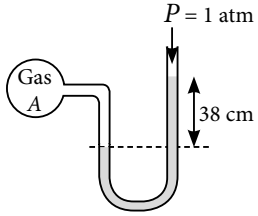
6.



Which of the following is incorrect?
(a) '*A*' shows disproportionation reaction in ammonia solution.
(b) Sulphide salt of metal presenting in '*C*' is soluble in aqua-regia.
(c) Anionic part of compound *B* has tetrahedral shape.
(d) *B* is Ag_2CrO_4.

COMPREHENSION

A manometer contains a liquid of density 5.44 g/cm^3 is attached to a flask containing gas '*A*' as follows :

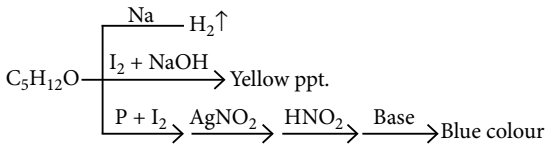


7. If the same liquid is used in barometer to measure the atmospheric pressure, then what will be the length of the liquid column, which exerts pressure equal to 1 atm? (density of Hg = 13.6 g/cm^3)
(a) 190 cm (b) 76 cm
(c) 30.4 cm (d) 266 cm

8. If gas *A* undergoes 30% trimerisation [$3A_{(g)} \rightleftharpoons A_{3(g)}$] then the difference in height of the liquid level in two columns is
(a) 38 cm (b) 7.6 cm (c) 3.04 cm (d) 15.1 cm

INTEGER VALUE

9. How many structural isomers having molecular formula $C_5H_{12}O$, can give following reactions?



10. The volume (in mL) of 0.1 M $AgNO_3$ required for complete precipitation of chloride ions present in 30 mL of 0.01 M solution of $[Cr(H_2O)_5Cl]Cl_2$, as silver chloride is

PRACTICE PAPER

NEET

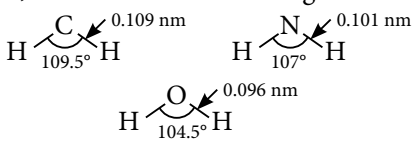
Exam on
6th May 2018

1. The lattice enthalpy and hydration enthalpy of four compounds are given below :

Compound	Lattice enthalpy (in kJ mol^{-1})	Hydration enthalpy (in kJ mol^{-1})
P	+780	– 920
Q	+ 1012	– 812
R	+ 828	– 878
S	+ 632	– 600

The pair of compounds which is soluble in water is
(a) *P* and *R* (b) *Q* and *R*
(c) *R* and *S* (d) *Q* and *S*

2. The bond length and bond angle in the molecules of methane, ammonia and water are given below :



This variation in bond angles is a result of
1. the increasing repulsion between hydrogen atoms as the bond length decreases
2. the number of non-bonding electron pairs in the molecule
3. a non-bonding electron pair having a greater repulsive force than a bonding electron pair.

Select the correct option.
(a) 1, 2 and 3 (b) Only 1 and 2
(c) Only 2 and 3 (d) Only 1

3. Which of the following statements is incorrect regarding the compounds of group 14 elements?
(a) Maximum coordination number of carbon in commonly occurring compounds is 4, whereas that of silicon is 6.
(b) The stability order of dihalides is $SiX_2 < GeX_2 < SnX_2 < PbX_2$.
(c) The order of boiling point of hydrides is $CH_4 < SiH_4 < GeH_4 < SnH_4$.
(d) $MeSiCl_3$ on hydrolysis and subsequent condensation will produce $(Me)Si(OH)_3$.

4. A solution containing one mole per litre of each $Cu(NO_3)_2$, $AgNO_3$, $Hg_2(NO_3)_2$ and $Mg(NO_3)_2$, is being electrolysed by using inert electrodes. The values of standard electrode potential in volts (reduction potentials) are Ag^+/Ag = +0.80, Hg_2^{2+}/Hg = +0.79, Cu^{2+}/Cu = +0.34, Mg^{2+}/Mg = – 2.37. The sequence of deposition of metals on the cathode is
(a) Ag, Hg, Cu, Mg (b) Mg, Cu, Hg, Ag
(c) Ag, Hg, Cu (d) Cu, Hg, Ag

5. A 0.020 m solution of each of the following compounds is prepared. Which solution would you expect to freeze at – 0.149 °C ?
(K_f (water) = 1.86 K kg mol^{-1})
(a) $[Co(en)_2Cl_2]Cl$ (b) Na[Co(EDTA)]
(c) $[Cr(py)_5Cl]Cl_2$ (d) $[Cr(NH_3)_6]Cl_3$

6. The root mean square speed of the molecules of a diatomic gas is *u*. When the temperature is doubled, the molecules dissociate into two atoms. The new *rms* speed of the atom is
(a) $\sqrt{2}u$ (b) u (c) $2u$ (d) $4u$

7. Neopentyl bromide undergoes dehydrohalogenation to give alkene even though it has no β-hydrogen. This is due to
(a) E_2 mechanism (b) E_1 mechanism
(c) rearrangement of carbocation by E_1 mechanism
(d) Hofmann elimination.

8. White phosphorus on reaction with lime water gives calcium salt of an acid (*A*) along with a gas (*X*). Which of the following statements is correct?
(a) (*A*) on heating gives (*X*) and O_2.
(b) The bond angle in (*X*) is less than that in case of ammonia.
(c) (*A*) is a dibasic acid.
(d) (*X*) is more basic than ammonia.

9. Which of the following order is wrong for given properties?

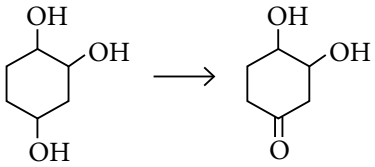
(a) $NH_3 < PH_3 < AsH_3$ — Acidic strength

(b) Li < Be < B < C — IE_1

(c) $Al_2O_3 < MgO < Na_2O < K_2O$ — Basic strength

(d) $Li^+ < Na^+ < K^+ < Cs^+$ — Ionic radius

10. Given conversion can be carried out by which of the following reagents :



(a) (i) Me_2CO/H^+ (ii) H_3O^+ (iii) $KMnO_4/OH^-$

(b) (i) Me_2CO/H^+ (ii) $KMnO_4/OH^-$ (iii) H_3O^+

(c) (i) $KMnO_4/NaIO_4$ (ii) Me_2CO/H^+ (iii) H_3O^+

(d) (i) $KMnO_4/NaIO_4$ (ii) H_3O^+ (iii) Me_2CO/H^+

11. Consider the following statements :

(i) Increase in concentration of reactant increases the rate of a zero order reaction.

(ii) Rate constant k is equal to collision frequency, A if $E_a = 0$.

(iii) Rate constant k is equal to collision frequency, A if $E_a = \infty$.

(iv) ln k *vs* $1/T$ graph is a straight line.

Correct statements are

(a) Only (i) and (iii) (b) Only (ii) and (iv)

(c) Only (iii) and (iv) (d) Only (ii) and (iii)

12. A compound with molecular formula C_7H_{16} shows optical isomerism, the compound will be

(a) 2, 3-dimethyl pentane

(b) 2, 2-dimethyl pentane

(c) 2-methyl hexane

(d) none of the above.

13. The melting point of RbBr is 682 °C while that of NaF is 988 °C. The melting point of NaF is much higher than RbBr, the principal reason for this, is

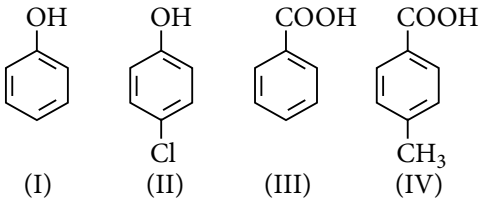
(a) the two crystals are not isomorphous

(b) the molar mass of NaF is smaller than that of RbBr

(c) the internuclear distance of RbBr is greater than that of NaF

(d) the bond in RbBr has more covalent character than the bond in NaF.

14. The correct acidity order of the following is



(I) (II) (III) (IV)

(a) (III) > (IV) > (II) > (I)

(b) (IV) > (III) > (I) > (II)

(c) (III) > (II) > (I) > (IV)

(d) (II) > (III) > (IV) > (I)

15. Solubility product constants (K_{sp}) of salts of types MX, MX_2 and M_3X at temperature T are 4.0×10^{-8}, 3.2×10^{-14} and 2.7×10^{-15} respectively. Solubility (mol dm^{-3}) of the salts at temperature 'T' are in the order

(a) $MX > MX_2 > M_3X$ (b) $M_3X > MX_2 > MX$

(c) $MX_2 > M_3X > MX$ (d) $MX > M_3X > MX_2$

16. Select the correct statement for the given reaction

$Na_2CrO_4 + H_2SO_4 \longrightarrow$

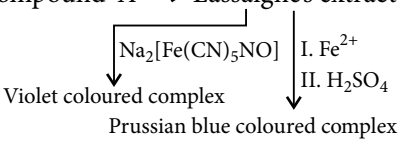
(a) It is a redox reaction in which green solution of $[Cr(H_2O)_6]^{3+}$ is produced.

(b) One of the product in reaction has trigonal planar structure.

(c) Dimeric bridged tetrahedral metal ion is produced.

(d) Dark blue coloured solution is obtained in reaction.

17. Organic compound 'A' $\longrightarrow$ Lassaigne's extract



The above Lassaigne's extract on treatment with Fe^{2+} does not give blood red colour because of the

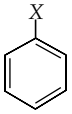
(a) absence of S in the organic compound

(b) presence of halogen in the organic compound

(c) dissociation of NaSCN into Na_2S and NaCN

(d) conversion of NaSCN into HSCN.

18. Which of the following compounds give only one product on mono-substitution?

(a)  (b)  (c)  (d) 

19. Which of the following is wrong?

(a) $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ – Mohr's salt

(b) $Na_2CO_3 \cdot 10H_2O$ – Washing soda

(c) $FeSO_4 \cdot 7H_2O$ – Green vitriol

(d) $CaSO_4 \cdot 2H_2O$ – Plaster of Paris

20. Match list I (reagents used with ethyne) with list II (products) and select the correct answer using the codes given below the lists.

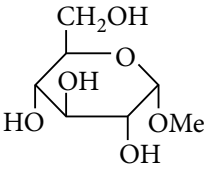
	List I	List II
P.	Hydrogen in presence of Pt/Pd/Ni	(i) Benzene
Q.	Heat at 600 °C in Cu-tube	(ii) Acetaldehyde
R.	Hydrogen in presence of Pd and $CaCO_3$ at 473 K	(iii) Ethene
S.	Water in presence of H_2SO_4 and $HgSO_4$	(iv) Ethane

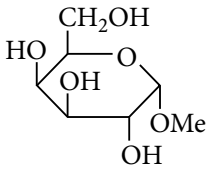
	P	Q	R	S
(a)	(ii)	(iii)	(iv)	(i)
(b)	(i)	(iv)	(iii)	(ii)
(c)	(i)	(iv)	(ii)	(iii)
(d)	(iv)	(i)	(iii)	(ii)

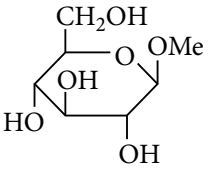
21. 3*d*-orbital has
(a) zero radial node (b) two total nodes
(c) two angular nodes (d) all of these.

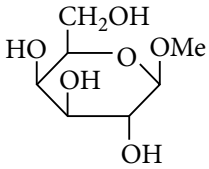
22. A metal *M* of equivalent mass *E* forms an oxide of molecular formula M_xO_y. The atomic mass of the metal is given by the correct equation
(a) $2E\ (y/x)$ (b) xyE
(c) E/y (d) y/E

23. The correct set of stereochemical relationship amongst the following monosaccharides is

I. 

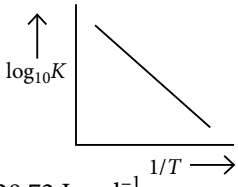
II. 

III. 

IV. 

(a) I and II are anomers; III and IV are epimers
(b) I and II are epimers; III and IV are anomers
(c) I and III are anomers; I and II are epimers
(d) I and III are epimers; II and IV are anomers.

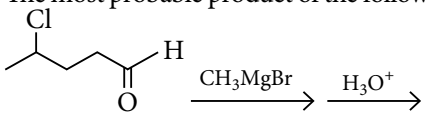
24. For the dissociation of $PCl_{5(g)}$, $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ slope of the linear curve is such that tan θ = (–2.1)
Thus, $\Delta H°$ is

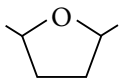


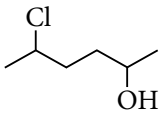
(a) 28.72 J mol^{-1} (b) –28.72 J mol^{-1}
(c) 40.2 J mol^{-1} (d) –12.47 J mol^{-1}

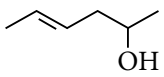
25. Structurally a biodegradable detergent should contain a
(a) normal alkyl chain
(b) branched alkyl chain
(c) phenyl side chain
(d) cyclohexyl side chain.

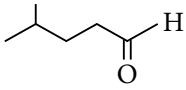
26. The most probable product of the following reaction is



(a) 

(b) 

(c) 

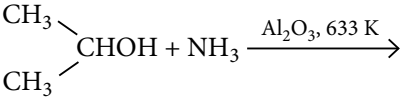
(d) 

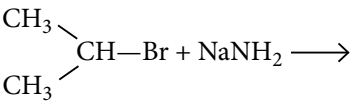
27. In a solid, oxide ions are arranged in *ccp*. One-sixth of tetrahedral voids are occupied by cation *A* while one-third of octahedral voids are occupied by cation *B*. The formula of compounds is
(a) AB_2O (b) A_2B_3O (c) ABO_3 (d) A_3B_2O

28. Isopropylamine cannot be obtained by

(a) $(CH_3)_2CO + NH_2OH \longrightarrow ? \xrightarrow{LiAlH_4}$

(b) $(CH_3)_2CO + NH_3 \xrightarrow{\Delta} ? \xrightarrow{H_2/Ni}$

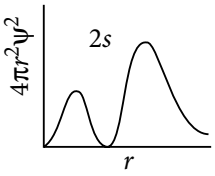
(c) 

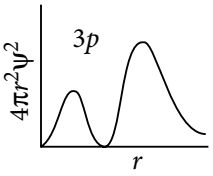
(d) 

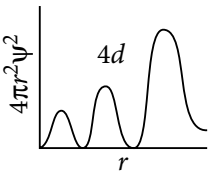
29. The freezing point of water is depressed by 0.37 °C in a 0.01 molal NaCl solution. The freezing point of 0.02 molal solution of urea is depressed by
(a) 0.37 °C (b) 0.74 °C
(c) 0.185 °C (d) 0 °C

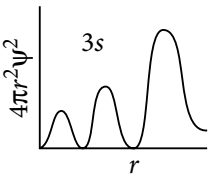
30. Which of the following statements is not true?
(a) In vulcanisation the rubber becomes harder and stronger.
(b) Natural rubber has '*trans*' configuration at every double bond.
(c) Buna-S is a copolymer of 1,3-butadiene and styrene.
(d) Natural rubber is 1,4-polymer of isoprene.

31. Which one of the following does not represent a correct plot of radial distribution function versus distance *r* from the nucleus?

(a) 

(b) 

(c) 

(d) 

32. Which of the following reactions will yield 2-propanol?

(i) $CH_3CH=CH_2 + H_2O \xrightarrow{H^+}$

(ii) $CH_3CHO \xrightarrow[(ii)\ H_2O]{(i)\ CH_3MgI}$

(iii) $HCHO \xrightarrow[(ii)\ H_2O]{(i)\ C_2H_5MgI}$

(iv) $CH_3CH=CH_2 \xrightarrow{\text{Neutral } KMnO_4}$

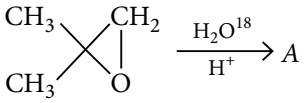
(a) Only (i) and (ii) (b) Only (ii) and (iii)
(c) Only (i) and (iii) (d) Only (ii) and (iv)

33. Which of the following properties are characteristic of lyophobic sols?

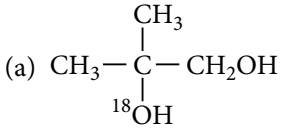
(i) Coagulation by electrolytes at low concentration
(ii) Reversible
(iii) Needs stabilising agents

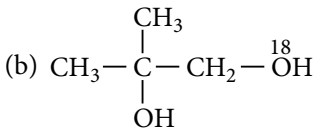
(a) (i), (ii) and (iii) (b) Only (i) and (iii)
(c) Only (i) and (ii) (d) None of these

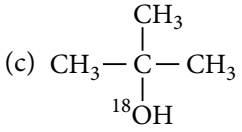
34. In the reaction,

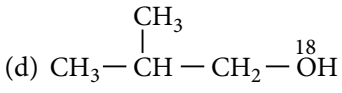


The product *A* is

(a) 

(b) 

(c) 

(d) 

35. The complex $[Fe(H_2O)_5NO]^{2+}$ is formed in the brown ring test for nitrates when freshly prepared $FeSO_4$ solution is added to aqueous solution of NO_3^- followed by addition of conc. H_2SO_4. Select the correct statement about this complex.

(a) Colour change is due to charge transfer.
(b) It has iron in +1 oxidation state and nitrosyl as NO^+.
(c) It has magnetic moment of 3.87 B.M. confirming three unpaired electrons in Fe.
(d) All of the above.

36. Sodium chloride imparts a golden yellow colour to the Bunsen flame. This can be interpreted due to

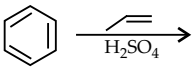
(a) low ionization enthalpy of sodium
(b) photosensitivity of sodium
(c) sublimation of metallic sodium to give yellow vapours
(d) emission of excess of energy absorbed as a radiation in the visible region.

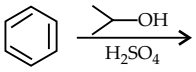
37. Which of the following statements is false?

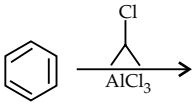
(a) The lower the concentration of D.O., the more polluted is the water sample.
(b) The tolerable limit of lead in drinking water is 50 ppb.
(c) Water is considered pure if it has BOD less than 5 ppm.
(d) In COD determination, the pollutants resistant to microbial oxidation are not oxidised by oxidising agents like $K_2Cr_2O_7$.

38. Which of the following reactions would give *iso*-propyl benzene as the major product?

(I) 

(II) 

(III) 

(IV) 

(a) Only I and IV (b) Only II and III
(c) Only II, III, IV (d) All of these

39. Freezing point of an aqueous solution is –0.186 °C. Elevation of boiling point of the same solution is (K_b = 0.512 K kg mol^{-1} and K_f = 1.86 K kg mol^{-1})

(a) 0.186 °C (b) 0.0512 °C
(c) 0.092 °C (d) 0.237 °C

40. During a redox titration involving a solution containing Fe^{2+} ions against MnO_4^- in the presence of excess of H^+ ions, the number of electrons that get transferred is

(a) 6 (b) 5 (c) 4 (d) 2

41. For a reaction, $A + B \longrightarrow$ Products, the rate of the reaction at various concentrations are given below :

Experiment	[A]	[B]	Rate (mol dm^{-3} s^{-1})
1	0.2	0.2	2
2	0.2	0.4	4
3	0.6	0.4	36

The rate law for the above reaction is

(a) $r = k[A]^2[B]$ (b) $r = k[A][B]^2$

(c) $r = k[A]^3[B]$ (d) $r = k[A]^2[B]^2$

42. Consider the following statements :

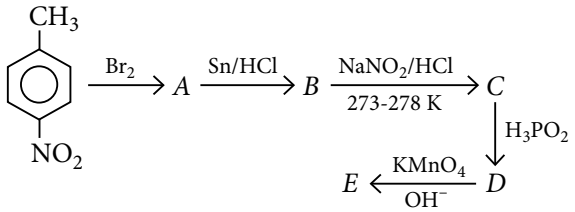
1. Atomic hydrogen is obtained by passing hydrogen gas through an electric arc.
2. Hydrogen gas will not reduce heated aluminium oxide.
3. Finely divided palladium absorbs large volume of hydrogen gas.
4. Pure nascent hydrogen is best obtained by reacting Na with C_2H_5OH.

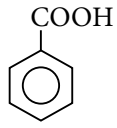
Which of the given statements is/are correct?

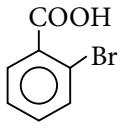
(a) Only 1 (b) Only 2

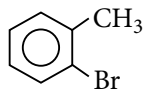
(c) Only 1, 2 and 3 (d) Only 2, 3 and 4

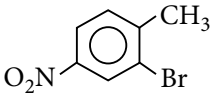
43. Identify the product (*E*) in the following sequence of reactions.



(a) 

(b) 

(c) 

(d) 

44. Which one of the following statements is not true regarding diborane?

(a) It has two bridging hydrogens and four terminal hydrogens.

(b) When methylated, the product is $Me_4B_2H_2$.

(c) The two bridge bonds (B---H---B) are three centre two electron bonds.

(d) All the B — H bond distances are equal.

45. In the electrolytic refining of zinc

(a) the impure metal is at the cathode

(b) acidified zinc sulphate is the electrolyte

(c) graphite is at the anode

(d) the metal ion gets reduced at the anode.

SOLUTIONS

1. (a) : A compound is soluble in water when its hydration enthalpy is greater than its lattice enthalpy.

2. (c)

3. (d) : Hydrolysis of $MeSiCl_3$ followed by condensation will produce silicones.

4. (c) : A cation having highest reduction potential will be reduced first and so on. However, Mg^{2+} in aqueous solution will not be reduced as $E^\circ_{Mg^{2+}/Mg} < E^\circ_{H_2O/\frac{1}{2}H_2+OH^-}$. Thus, water would be reduced instead of Mg^{2+}.

5. (d) : As we know,

$$\Delta T_f = i \times K_f \times m$$

So, $T_f^\circ - T_f = i \times K_f \times m$

$0.149 = i \times 1.86 \times 0.020$

Hence, $i = 4$

The compound having the value of $i = 4$ will have the freezing point –0.149 °C *i.e.*, $[Cr(NH_3)_6]Cl_3$.

6. (c) : $u = \sqrt{\frac{3RT}{M}}$

If $T_1 = 2T$ and $M_1 = M/2$, then $u_1 = \sqrt{\frac{3R \times 2T}{M/2}}$

$\therefore \quad \frac{u_1}{u} = \sqrt{4} = 2 \quad \Rightarrow \quad u_1 = 2u$

7. (c)

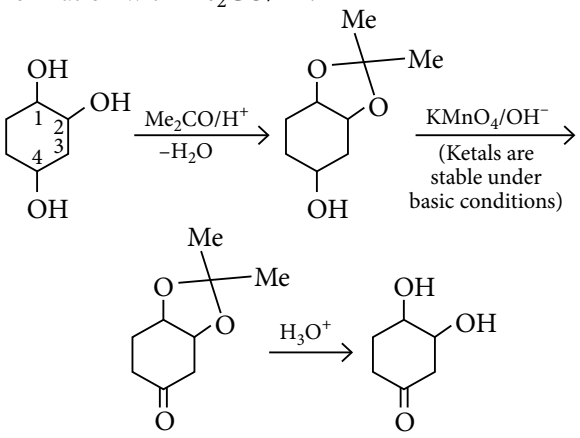
8. (b) : $2P_4 + 3Ca(OH)_2 + 6H_2O \longrightarrow 3Ca(H_2PO_2)_2 + 2PH_3$ (*X*)

(*A*) is H_3PO_2 (hypophosphorous acid), a monobasic acid. PH_3 is less basic than NH_3. The bond angle in PH_3 is less than that present in NH_3.

H_3PO_2 on heating gives orthophosphoric acid and phosphine (*X*).

9. (b)

10. (b) : Since C_4—OH is to be oxidised, therefore, —OH groups at C_1 and C_2 are protected by ketal formation with Me_2CO/H^+.



11. (b) : (i) For a zero order reaction, the rate is independent of concentration of reactant.

(ii) According to Arrhenius equation, $k = Ae^{-E_a/RT}$

$\therefore$ when $E_a = 0$, $k = A$

(iii) When $E_a = \infty$, $k < A$

(iv) $\ln k$ *vs* $1/T$ graph is a straight line with slope $= -E_a/R$.

12. (a) **13. (c)**

14. (a)

15. (d) : $MX \rightleftharpoons M^+ + X^-$

Solubility of $MX(x_1) = \sqrt{4\times10^{-8}} = 2\times10^{-4}$

$MX_2 \rightleftharpoons M^{2+} + 2X^-$

Solubility of $MX_2(x_2) \Rightarrow 4x_2^3 = K_{sp}$

$$\therefore \quad x_2 = \left(\frac{K_{sp}}{4}\right)^{1/3} = \left(\frac{3.2\times10^{-14}}{4}\right)^{1/3} = 2\times10^{-5}$$

$M_3X \rightleftharpoons 3M^+ + X^{3-}$

Solubility of $M_3X(x_3) \Rightarrow 27x_3^4 = 2.7 \times 10^{-15} \Rightarrow x_3 = 10^{-4}$

$\therefore \quad x_1 > x_3 > x_2 \quad \Rightarrow \quad MX > M_3X > MX_2$

16. (c) : $\underset{\text{(Yellow)}}{2CrO_4^{2-}} \underset{OH^-}{\overset{2H^+}{\rightleftharpoons}} \underset{\text{(Orange)}}{Cr_2O_7^{2-}} + H_2O$

17. (c) : Lassaigne's extract gives violet colour complex, it clearly confirms the presence of sulphur. The formation of Prussian blue coloured complex confirms the presence of nitrogen. If Lassaigne's extract does not give red colour complex it means excess of Na metal caused dissociation of NaSCN into Na_2S and NaCN.

$$2Na + NaSCN \xrightarrow{\Delta} Na_2S + NaCN$$

18. (c) **19. (d)**

20. (d) **21. (d)**

22. (a) : x atoms of M combine with y atoms of oxygen. 1 atom of M combines with y/x atoms of oxygen.

Hence, valency $= \frac{2y}{x}$

Atomic mass = Equivalent mass × valency

Atomic mass $= \frac{E\times2y}{x} = \frac{2Ey}{x}$

23. (c) : I and III differ in configuration at C_1 and hence are anomers while I and II differ in configuration at C_4 and hence are epimers.

24. (c) : van't Hoff isochoric equation is

$$\log_{10}K = -\frac{\Delta H^\circ}{2.303RT} + \frac{\Delta S^\circ}{2.303\,R}$$

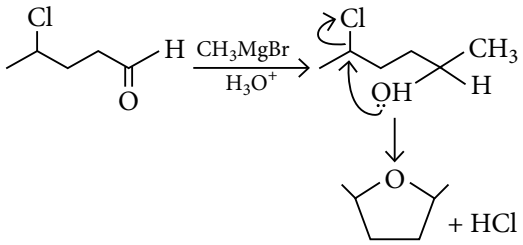
Graph between $\log_{10}K$ and $\frac{1}{T}$ is linear.

$$\text{Slope} = -\frac{\Delta H^\circ}{2.303R} = \tan\theta = -2.1$$

$\therefore \quad \Delta H^\circ = 2.303\,R \times 2.1 = 2.303 \times 8.314 \times 2.1 = 40.2\ \text{J mol}^{-1}$

25. (a)

26. (a) :



If possible, intramolecular reaction is preferred over intermolecular reaction.

27. (c) : Suppose number of O^{2-} ions = n, number of octahedral voids = n and number of tetrahedral voids = $2n$,

Cation $A = \frac{1}{6} \times 2n = \frac{n}{3}$; Cation $B = \frac{1}{3} \times n = \frac{n}{3}$

Ratio $= A : B : O^{2-} = \frac{n}{3} : \frac{n}{3} : n$

Formula of the compound is ABO_3.

28. (d) : $NaNH_2$ does not give substitution but gives elimination product, *i.e.,* propene.

29. (a) : The depression in freezing point is proportional to molal concentration of the solute *i.e.,* $\Delta T_f \propto m$.

$$\Delta T_f = K_f m \times i \quad \text{or} \quad K_f = \frac{\Delta T_f}{i \times m}$$

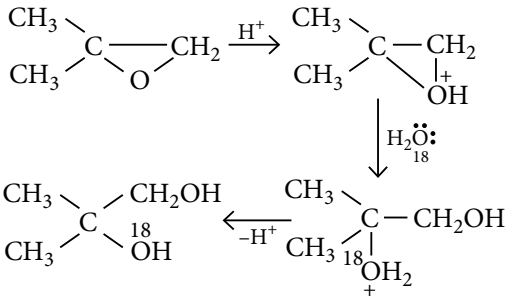
so, $$\frac{\Delta T_{f_{(NaCl)}}}{i_{(NaCl)} \times m_{(NaCl)}} = \frac{\Delta T_{f_{(Urea)}}}{m_{(Urea)} \times i_{(Urea)}}$$

$$\frac{0.37}{2\times0.01} = \frac{\Delta T_{f_{(Urea)}}}{0.02\times1} \Rightarrow \Delta T_{f_{(Urea)}} = \frac{0.37\times0.02}{0.02} = 0.37\ ^\circ\text{C}$$

30. (b) **31. (c)**

32. (a) **33. (b)**

34. (a) :

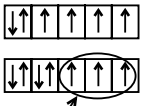


35. (d) : $NO \longrightarrow NO^+ + e^-$

$Fe^{2+} + e^- \longrightarrow Fe^+$

$Fe^{2+} = [Ar]\ 3d^6$

$Fe^+ = [Ar]\ 3d^7$



Three unpaired electrons

$\mu = \sqrt{n(n+2)} = \sqrt{3(3+2)}$

$= 3.87$ B.M.

36. (d) **37. (d)** **38. (d)**

39. (b) : $\Delta T_f = \dfrac{1000 \times K_f \times w}{W \times m}$

and $\Delta T_b = \dfrac{1000 \times K_b \times w}{W \times m}$

$\therefore \quad \dfrac{\Delta T_f}{\Delta T_b} = \dfrac{K_f}{K_b}$ or $\dfrac{0.186}{\Delta T_b} = \dfrac{1.86}{0.512}$

$\therefore \quad \Delta T_b = 0.0512\ °C$

40. (b)

41. (a) : $A + B \longrightarrow$ Products

Rate $= k\,[A]^{\alpha}\,[B]^{\beta}$

From expt. No. 1, $2 = k\,[0.2]^{\alpha}\,[0.2]^{\beta}$ ...(1)

From expt. No. 2, $4 = k\,[0.2]^{\alpha}\,[0.4]^{\beta}$ ...(2)

Dividing eq. (1) and (2), we get

$\dfrac{2}{4} = \dfrac{k\,[0.2]^{\alpha}[0.2]^{\beta}}{k\,[0.2]^{\alpha}[0.4]^{\beta}}$ or $\dfrac{1}{2} = \left[\dfrac{1}{2}\right]^{\beta} \Rightarrow \beta = 1$

From expt. No. 3, $36 = k\,[0.6]^{\alpha}\,[0.4]^{\beta}$ ...(3)

Dividing eqn. (2) and (3), we get

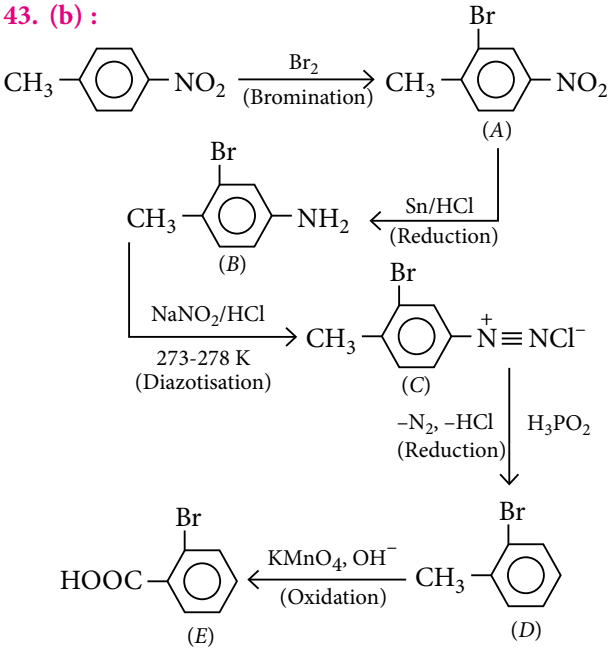
$\dfrac{4}{36} = \dfrac{k[0.2]^{\alpha}[0.4]^{\beta}}{k[0.6]^{\alpha}[0.4]^{\beta}}$ or $\dfrac{1}{9} = \left[\dfrac{1}{3}\right]^{\alpha} \Rightarrow \alpha = 2$

$\Rightarrow$ Rate law for the given reaction is, $r = k\,[A]^2\,[B]^1$

42. (c) : Pure hydrogen is evolved by reacting absolute alcohol with Na.

$C_2H_5OH + Na \longrightarrow C_2H_5\overset{-}{O}\overset{+}{N}a + 1/2H_2$

43. (b) :



44. (d)

45. (b) : In this method, the impure metal is made to act as anode while cathode is made up of a pure strip of the same metal. These electrodes are suspended in an electrolyte which is the acidified solution of a soluble salt of the same metal.

07

Most frequently asked chapters in

JEE ADVANCED

- Chemical Bonding
- Chemical Energetics
- The *p*-Block Elements
- Coordination Compounds
- Hydrocarbons
- Aldehydes, Ketones, Carboxylic Acids and Their Derivatives
- Compounds Containing Nitrogen

Questions from last 3 years (2017-2015) are covered here to give you an idea to score high in exam.

Chemical Bonding

1. The sum of the number of lone pairs of electrons on each central atom in the following species is $[TeBr_6]^{2-}$, $[BrF_2]^+$, SNF_3, and $[XeF_3]^-$
(Atomic numbers: N = 7, F = 9, S = 16, Br = 35, Te = 52, Xe = 54) *(2017)*

2. Among H_2, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2^-, and F_2 the number of diamagnetic species is
(Atomic numbers: H = 1, He = 2, Li = 3, Be = 4, B= 5, C = 6, N = 7, O = 8, F = 9) *(2017)*

3. The compound(s) with two lone pairs of electrons on the central atom is(are)
(a) BrF_5 (b) ClF_3 (c) XeF_4 (d) SF_4 *(2016)*

4. According to molecular orbital theory,
(a) C_2^{2-} is expected to be diamagnetic
(b) O_2^{2+} is expected to have a longer bond length than O_2
(c) N_2^+ and N_2^- have the same bond order
(d) He_2^+ has the same energy as two isolated He atoms. *(2016)*

5. The total number of lone pairs of electrons in N_2O_3 is *(2015)*

6. Among the triatomic molecules/ions, $BeCl_2$, N_3^-, N_2O, NO_2^+, O_3, SCl_2, ICl_2^-, I_3^- and XeF_2, the total number of linear molecule(s)/ion(s) where the hybridization of the central atom does not have contribution from the *d*-orbital(s) is
[Atomic number : S = 16, Cl = 17, I = 53 and Xe = 54] *(2015)*

7. When O_2 is adsorbed on a metallic surface, electron transfer occurs from the metal to O_2. The TRUE statement(s) regarding this adsorption is(are)
(a) O_2 is physisorbed
(b) heat is released
(c) occupancy of π^*_{2p} of O_2 is increased
(d) bond length of O_2 is increased. *(2015)*

Chemical Energetics

8. An ideal gas is expanded from (p_1, V_1, T_1) to (p_2, V_2, T_2) under different conditions. The correct statement(s) among the following is(are)
(a) if the expansion is carried out freely, it is simultaneously both isothermal as well as adiabatic.
(b) the work done by the gas is less when it is expanded reversibly from V_1 to V_2 under adiabatic conditions as compared to that when expanded reversibly from V_1 to V_2 under isothermal conditions
(c) the work done on the gas is maximum when it is compressed irreversibly from (p_2, V_2) to (p_1, V_1) against constant pressure p_1
(d) the change in internal energy of the gas is (i) zero, if it is expanded reversibly with $T_1 = T_2$, and (ii) positive, if it is expanded reversibly under adiabatic conditions with $T_1 \neq T_2$. *(2017)*

9. The standard state Gibbs free energies of formation of $C_{(graphite)}$ and $C_{(diamond)}$ at $T = 298$ K are
$\Delta_f G°[C_{(graphite)}] = 0$ kJ mol^{-1}
$\Delta_f G°[C_{(diamond)}] = 2.9$ kJ mol^{-1}
The standard state means that the pressure should be 1 bar, and substance should be pure at a given temperature. The conversion of graphite $[C_{(graphite)}]$ to diamond $[C_{(diamond)}]$ reduces its volume by 2×10^{-6} m^3 mol^{-1}. If $C_{(graphite)}$ is converted to $C_{(diamond)}$ isothermally at $T = 298$ K, the pressure at which $C_{(graphite)}$ is in equilibrium with $C_{(diamond)}$, is
[Useful information: 1 J = 1 kg m^2 s^{-2}; 1 Pa = 1 kg m^{-1} s^{-2}; 1 bar = 10^5 Pa]
(a) 29001 bar (b) 58001 bar
(c) 14501 bar (d) 1450 bar *(2017)*

10. One mole of an ideal gas at 300 K in thermal contact with surroundings expands isothermally from 1.0 L to 2.0 L against a constant pressure of 3.0 atm. In this process, the change in entropy of surroundings (ΔS_{surr}) in J K^{-1} is (1 L atm = 101.3 J)
(a) 5.763 (b) 1.013 (c) −1.013 (d) −5.763 *(2016)*

11. Match the thermodynamic processes given under Column I with the expressions given under Column II.

Column I	Column II
(A) Freezing of water at 273 K and 1 atm	(P) $q = 0$
(B) Expansion of 1 mol of an ideal gas into a vacuum under isolated conditions	(Q) $w = 0$
(C) Mixing of equal volumes of two ideal gases at constant temperature and pressure in an isolated container	(R) $\Delta S_{sys} < 0$
(D) Reversible heating of $H_{2(g)}$ at 1 atm from 300 K to 600 K, followed by reversible cooling to 300 K at 1 atm	(S) $\Delta U = 0$
	(T) $\Delta G = 0$

(2015)

Paragraph for Questions 12 and 13

When 100 mL of 1.0 M HCl was mixed with 100 mL of 1.0 M NaOH in an insulated beaker at constant pressure, a temperature increase of 5.7 °C was measured for the beaker and its contents (Expt. 1). Because the enthalpy of neutralization of a strong acid with a strong base is a constant (−57.0 kJ mol^{-1}), this experiment could be used to measure the calorimeter constant.

In a second experiment (Expt. 2), 100 mL of 2.0 M acetic acid ($K_a = 2.0 \times 10^{-5}$) was mixed with 100 mL of 1.0 M NaOH (under identical conditions to Expt. 1) where a temperature rise of 5.6 °C was measured.
(Consider heat capacity of all solutions as 4.2 J g^{-1} K^{-1} and density of all solutions as 1.0 g mL^{-1})

12. Enthalpy of dissociation (in kJ mol^{-1}) of acetic acid obtained from the Expt. 2 is
(a) 1.0 (b) 10.0 (c) 24.5 (d) 51.4 *(2015)*

13. The pH of the solution after Expt. 2 is
(a) 2.8 (b) 4.7 (c) 5.0 (d) 7.0 *(2015)*

The *p*-Block Elements

14. The colour of the X_2 molecules of group 17 elements changes gradually from yellow to violet down the group. This is due to
(a) the physical state of X_2 at room temperature changes from gas to solid down the group
(b) decrease in HOMO-LUMO gap down the group
(c) decrease in π^*–σ^* gap down the group
(d) decrease in ionization energy down the group. *(2017)*

15. The correct statement(s) about the oxoacids, $HClO_4$ and HClO, is(are)
(a) the conjugate base of $HClO_4$ is weaker base than H_2O
(b) the central atom in both $HClO_4$ and HClO is sp^3 hybridized
(c) $HClO_4$ is formed in the reaction between Cl_2 and H_2O
(d) $HClO_4$ is more acidic than HClO because of the resonance stabilization of its anion. *(2017)*

16. The order of the oxidation state of the phosphorus atom in H_3PO_2, H_3PO_4, H_3PO_3, and $H_4P_2O_6$ is
(a) $H_3PO_4 > H_3PO_2 > H_3PO_3 > H_4P_2O_6$
(b) $H_3PO_2 > H_3PO_3 > H_4P_2O_6 > H_3PO_4$
(c) $H_3PO_3 > H_3PO_2 > H_3PO_4 > H_4P_2O_6$
(d) $H_3PO_4 > H_4P_2O_6 > H_3PO_3 > H_3PO_2$ *(2017)*

17. Among the following, the correct statement(s) is(are)
(a) $Al(CH_3)_3$ has the three-centre two-electron bonds in its dimeric structure
(b) BH_3 has the three-centre two-electron bonds in its dimeric structure
(c) the Lewis acidity of BCl_3 is greater than that of $AlCl_3$
(d) $AlCl_3$ has the three-centre two-electron bonds in its dimeric structure. *(2017)*

Paragraph for Questions 18 and 19

Upon heating $KClO_3$ in the presence of catalytic amount of MnO_2, a gas *W* is formed. Excess amount of *W* reacts with white phosphorus to give *X*. The reaction of *X* with pure HNO_3 gives *Y* and *Z*.

18. *Y* and *Z* are, respectively
(a) N_2O_5 and HPO_3 (b) N_2O_3 and H_3PO_4
(c) N_2O_4 and H_3PO_3 (d) N_2O_4 and HPO_3 *(2017)*

19. *W* and *X* are, respectively
(a) O_2 and P_4O_6 (b) O_2 and P_4O_{10}
(c) O_3 and P_4O_6 (d) O_3 and P_4O_{10} *(2017)*

20. The increasing order of atomic radii of the following group 13 elements is
(a) Al < Ga < In < Tl (b) Ga < Al < In < Tl
(c) Al < In < Ga < Tl (d) Al < Ga < Tl < In
(2016)

21. The crystalline form of borax has
(a) tetranuclear $[B_4O_5(OH)_4]^{2-}$ unit
(b) all boron atoms in the same plane
(c) equal number of sp^2 and sp^3 hybridized boron atoms
(d) one terminal hydroxide per boron atom. *(2016)*

22. The nitrogen containing compound produced in the reaction of HNO_3 with P_4O_{10}
(a) can also be prepared by reaction of P_4 and HNO_3
(b) is diamagnetic
(c) contains one N—N bond
(d) reacts with Na metal producing brown gas.
(2016)

23. Three moles of B_2H_6 are completely reacted with methanol. The number of moles of boron containing product formed is *(2015)*

24. The correct statement(s) regarding, (i) HClO, (ii) $HClO_2$, (iii) $HClO_3$ and (iv) $HClO_4$, is(are)
(a) the number of Cl═O bonds in (ii) and (iii) together is two
(b) the number of lone pairs of electrons on Cl in (ii) and (iii) together is three
(c) the hybridization of Cl in (iv) is sp^3
(d) amongst (i) to (iv), the strongest acid is (i).
(2015)

25. Under hydrolytic conditions, the compounds used for preparation of linear polymer and for chain termination, respectively, are
(a) CH_3SiCl_3 and $Si(CH_3)_4$
(b) $(CH_3)_2SiCl_2$ and $(CH_3)_3SiCl$
(c) $(CH_3)_2SiCl_2$ and CH_3SiCl_3
(d) $SiCl_4$ and $(CH_3)_3SiCl$ *(2015)*

Coordination Compounds

26. Among $[Ni(CO)_4]$, $[NiCl_4]^{2-}$, $[Co(NH_3)_4Cl_2]Cl$, $Na_3[CoF_6]$, Na_2O_2 and CsO_2, the total number of paramagnetic compounds is
(a) 2 (b) 3 (c) 4 (d) 5 *(2016)*

27. The number of geometric isomers possible for the complex $[CoL_2Cl_2]^-$ ($L = H_2NCH_2CH_2O^-$) is *(2016)*

28. The geometries of the ammonia complexes of Ni^{2+}, Pt^{2+} and Zn^{2+}, respectively, are
(a) octahedral, square planar and tetrahedral
(b) square planar, octahedral and tetrahedral
(c) tetrahedral, square planar and octahedral
(d) octahedral, tetrahedral and square planar.
(2016)

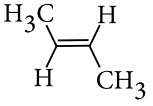
29. For the octahedral complexes of Fe^{3+} in SCN^- (thiocyanato-S) and in CN^- ligand environments, the difference between the spin-only magnetic moments in Bohr magnetons (when approximated to the nearest integer) is
[Atomic number of Fe = 26] *(2015)*

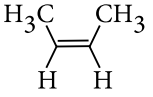
30. In the complex acetylbromidodicarbonylbis (triethyl-phosphine)iron(II), the number of Fe—C bond(s) is *(2015)*

31. Among the complex ions,
$[Co(NH_2CH_2CH_2NH_2)_2Cl_2]^+$, $[CrCl_2(C_2O_4)_2]^{3-}$, $[Fe(H_2O)_4(OH)_2]^+$, $[Fe(NH_3)_2(CN)_4]^-$, $[Co(NH_2CH_2CH_2NH_2)_2(NH_3)Cl]^{2+}$ and $[Co(NH_3)_4(H_2O)Cl]^{2+}$,
the number of complex ion(s) that show(s) *cis-trans* isomerism is *(2015)*

Hydrocarbons

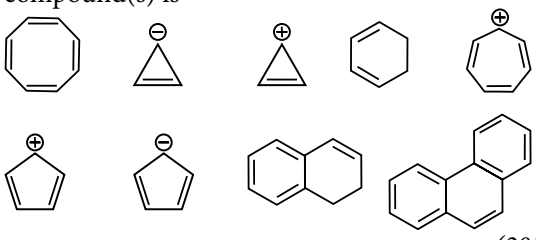
32. The correct statement(s) for the following addition reactions is(are)

(i)  $\xrightarrow{Br_2/CHCl_3}$ *M* and *N*

(ii)  $\xrightarrow{Br_2/CHCl_3}$ *O* and *P*

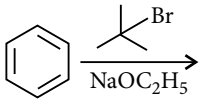
(a) *O* and *P* are identical molecules
(b) bromination proceeds through *trans*-addition in both the reactions
(c) (*M* and *O*) and (*N* and *P*) are two pairs of enantiomers
(d) (*M* and *O*) and (*N* and *P*) are two pairs of diastereomers. *(2017)*

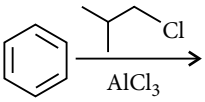
33. Among the following, the number of aromatic compound(s) is

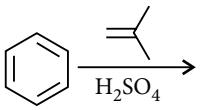


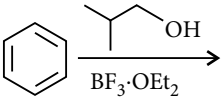
(2017)

34. Among the following, reaction(s) which gives(give) *tert*-butyl benzene as the major product is(are)

(a) 

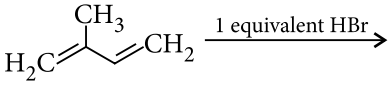
(b) 

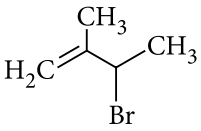
(c) 

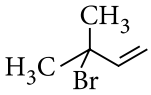
(d) 

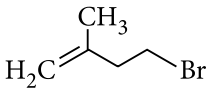
(2016)

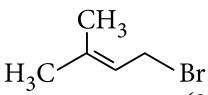
35. In the following reaction, the major product is



(a) 

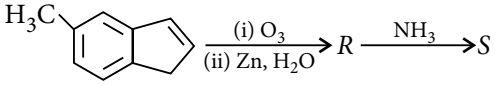
(b) 

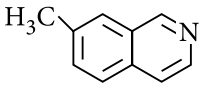
(c) 

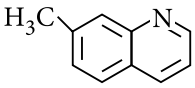
(d) 

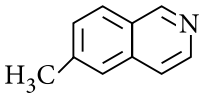
(2015)

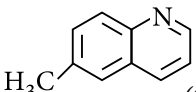
36. In the following reactions, the product *S* is



(a) 

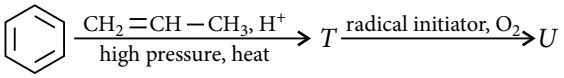
(b) 

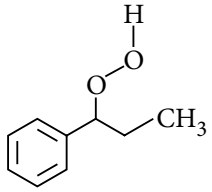
(c) 

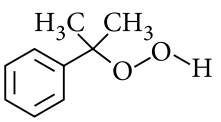
(d) 

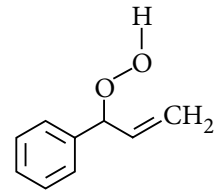
(2015)

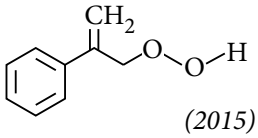
37. The major product *U* in the following reaction is



(a) 

(b) 

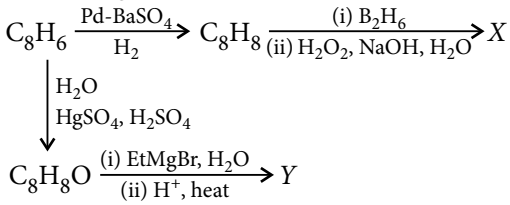
(c) 

(d) 

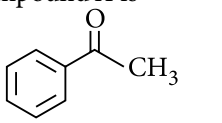
(2015)

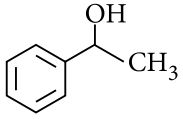
Paragraph for Questions 38 and 39

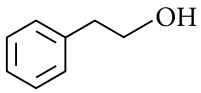
In the following reactions,

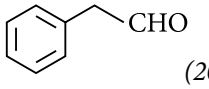


38. Compound *X* is

(a) 

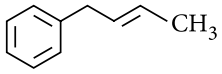
(b) 

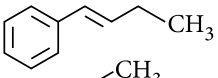
(c) 

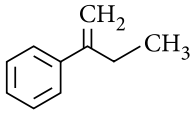
(d) 

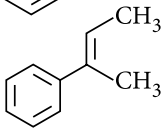
(2015)

39. The major compound *Y* is

(a) 

(b) 

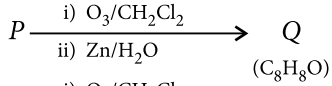
(c) 

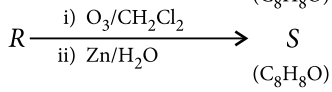
(d) 

(2015)

Aldehydes, Ketones, Carboxylic acids and their Derivatives

40. Compounds *P* and *R* upon ozonolysis produce *Q* and *S* respectively. The molecular formula of *Q* and *S* is C_8H_8O. *Q* undergoes Cannizzaro reaction but not haloform reaction, whereas *S* undergoes haloform reaction but not Connizzaro reaction.

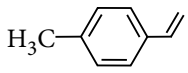
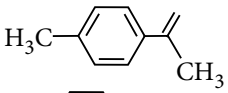
(i) 

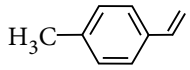
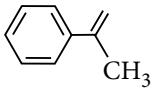
(ii) 

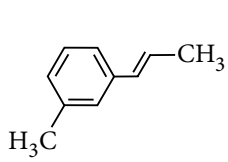
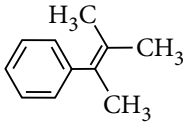
MPP CLASS XI ANSWER KEY

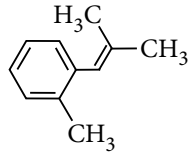
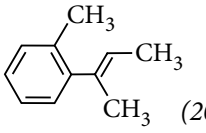
1. (b)	**2.** (b)	**3.** (b)	**4.** (a)	**5.** (d)
6. (c)	**7.** (c)	**8.** (c)	**9.** (d)	**10.** (a)
11. (b)	**12.** (c)	**13.** (d)	**14.** (b)	**15.** (a)
16. (b)	**17.** (a)	**18.** (c)	**19.** (d)	**20.** (a,b)
21. (b,d)	**22.** (c,d)	**23.** (a,c)	**24.** (2)	**25.** (1)
26. (4)	**27.** (a)	**28.** (d)	**29.** (b)	**30.** (c)

The option(s) with suitable combination of *P* and *R*, respectively, is (are)

(a)  and 

(b)  and 

(c)  and 

(d)  and  *(2017)*

Answer Q. 41, Q. 42 and Q. 43 by appropriately matching the information given in the three columns of the following table.

Columns 1, 2, and 3 contain starting materials, reaction conditions, and type of reactions, respectively.

Column 1	Column 2	Column 3
(I) Toluene	(i) NaOH/ Br_2	(P) Condensation
(II) Acetophenone	(ii) $Br_2/h\nu$	(Q) Carboxylation
(III) Benzaldehyde	(iii) $(CH_3CO)_2O$/ CH_3COOK	(R) Substitution
(IV) Phenol	(iv) NaOH/ CO_2	(S) Haloform

41. The only correct combination in which the reaction proceeds through radical mechanism is

(a) (II) (iii) (R) (b) (III) (ii) (P)

(c) (IV) (i) (Q) (d) (I) (ii) (R) *(2017)*

42. For the synthesis of benzoic acid, the only correct combination is

(a) (III) (iv) (R) (b) (IV) (ii) (P)

(c) (II) (i) (S) (d) (I) (iv) (Q) *(2017)*

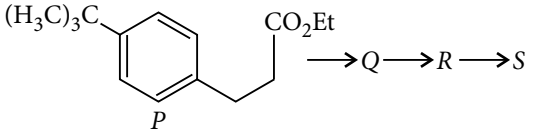
43. The only correct combination that gives two different carboxylic acids is

(a) (IV) (iii) (Q) (b) (I) (i) (S)

(c) (III) (iii) (P) (d) (II) (iv) (R) *(2017)*

Paragraph for Questions 44 and 45

The reaction of compound *P* with CH_3MgBr (excess) in $(C_2H_5)_2O$ followed by addition of H_2O gives *Q*. The compound *Q* on treatment with H_2SO_4 at 0 °C gives *R*. The reaction of *R* with CH_3COCl in the presence of anhydrous $AlCl_3$ in CH_2Cl_2 followed by treatment with H_2O produces compound *S*. [Et in compound *P* is ethyl group]



P

44. The reactions, *Q* to *R* and *R* to *S*, are

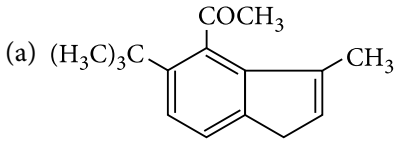
(a) Friedel–Crafts alkylation and Friedel–Crafts acylation

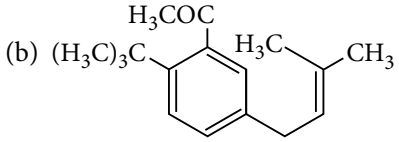
(b) dehydration and Friedel–Crafts acylation

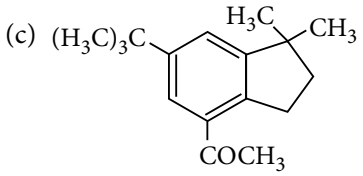
(c) Friedel–Crafts alkylation, dehydration and Friedel–Crafts acylation

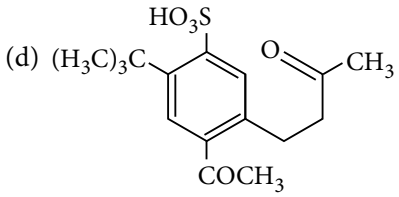
(d) aromatic sulphonation and Friedel–Crafts acylation. *(2017)*

45. The products *S* is

(a) 

(b) 

(c) 

(d)  *(2017)*

46. The correct statement(s) about the following reaction sequence is(are)

$$\text{Cumene}(C_9H_{12}) \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } O_2} P \xrightarrow[\text{NaOH}]{CHCl_3/} \underset{\text{(Major)}}{Q} + \underset{\text{(Minor)}}{R}$$

$$Q \xrightarrow[PhCH_2Br]{NaOH} S$$

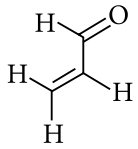
(a) *R* is steam volatile

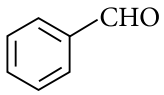
(b) *Q* gives dark violet colouration with 1% aqueous $FeCl_3$ solution

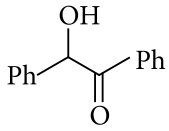
(c) *S* gives yellow precipitate with 2, 4-dinitrophenylhydrazine

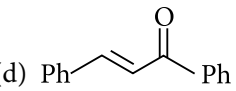
(d) *S* gives dark violet colouration with 1% aqueous $FeCl_3$ solution. *(2016)*

47. Positive Tollens' test is observed for

(a) 

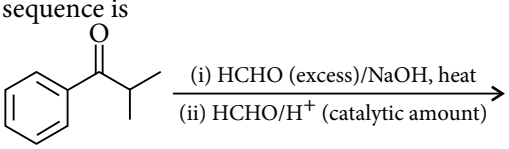
(b) 

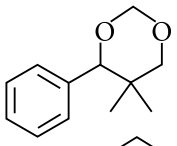
(c) 

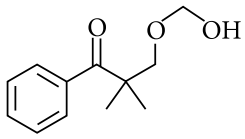
(d) 

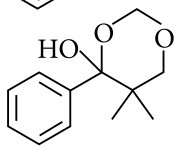
(2016)

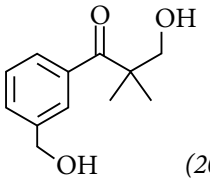
48. The major product of the following reaction sequence is



(a) 

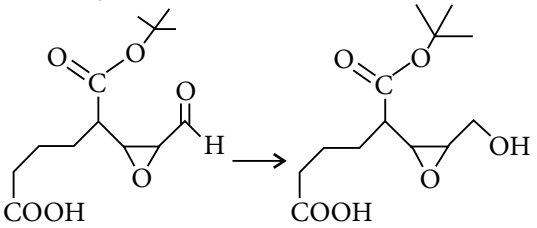
(b) 

(c) 

(d) 

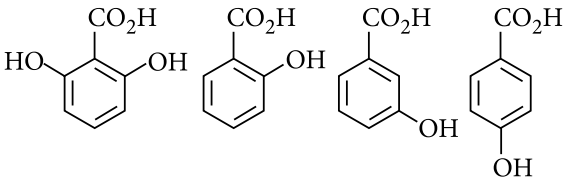
(2016)

49. Reagent(s) which can be used to bring about the following transformation is(are)



(a) $LiAlH_4$ in $(C_2H_5)_2O$
(b) BH_3 in THF
(c) $NaBH_4$ in C_2H_5OH
(d) Raney Ni/H_2 in THF. *(2016)*

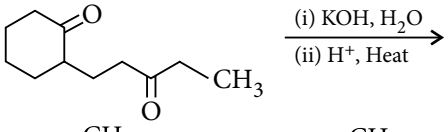
50. The correct order of acidity for the following compounds is

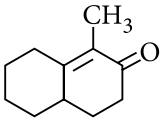


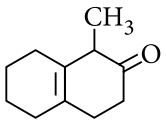
I II III IV

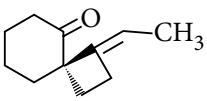
(a) I > II > III > IV (b) III > I > II > IV
(c) III > IV > II > I (d) I > III > IV> II *(2016)*

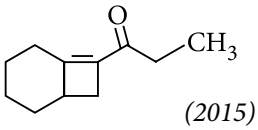
51. The major product of the following reaction is



(a) 

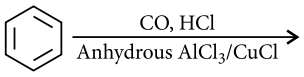
(b) 

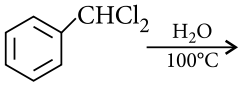
(c) 

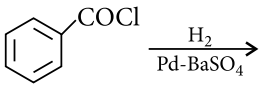
(d) 

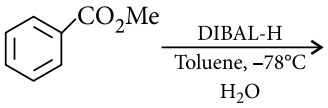
(2015)

52. Among the following, the number of reaction(s) that produce(s) benzaldehyde is

I. 

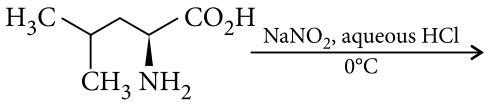
II. 

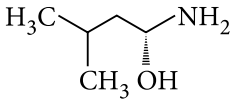
III. 

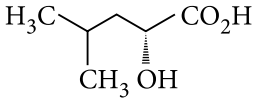
IV. 

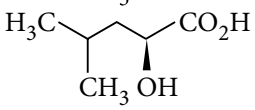
(2015)

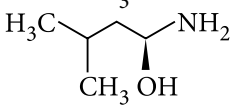
53. The major product of the reaction is



(a) 

(b) 

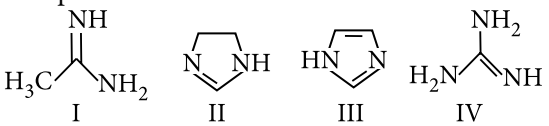
(c) 

(d) 

(2015)

Compounds Containing Nitrogen

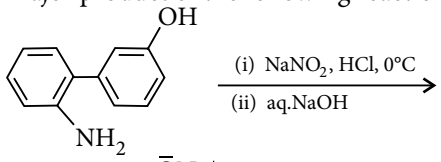
54. The order of basicity among the following compounds is

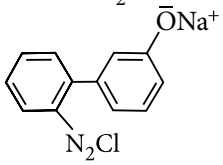


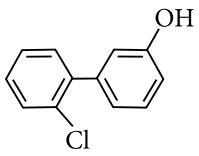
I II III IV

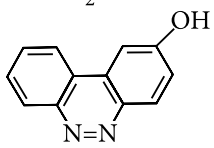
(a) IV > II > III > I (b) II > I > IV > III
(c) I > IV > III > II (d) IV > I > II > III *(2017)*

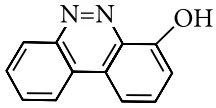
55. The major product of the following reaction is



(a) 

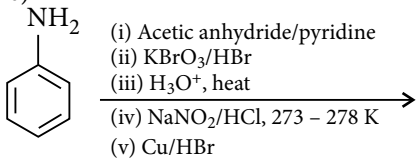
(b) 

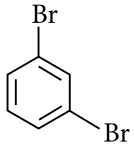
(c) 

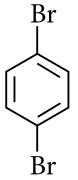
(d) 

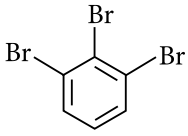
(2017)

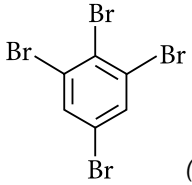
56. The product(s) of the following reaction sequence is(are)



(a) 

(b) 

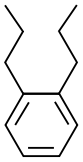
(c) 

(d) 

(2016)

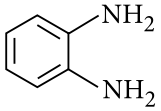
Paragraph for Questions 57 and 58

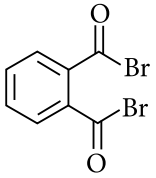
Treatment of compound *O* with $KMnO_4/H^+$ gave *P*, which on heating with ammonia gave *Q*. The compound *Q* on treatment with Br_2/NaOH produced *R*. On strong heating, *Q* gave *S*, which on further treatment with ethyl 2-bromopropanoate in the presence of KOH followed by acidification, gave a compound *T*.

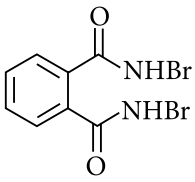


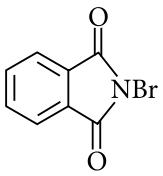
(O)

57. The compound *R* is

(a) 

(b) 

(c) 

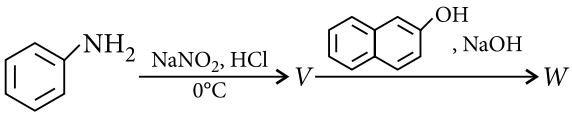
(d) 

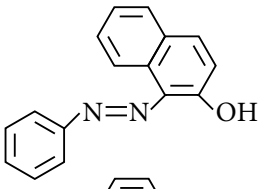
(2016)

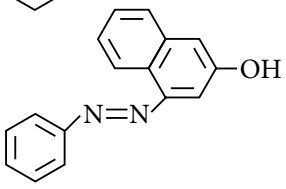
58. The compound *T* is

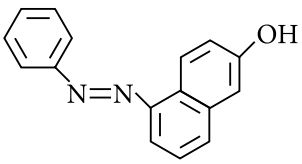
(a) glycine (b) alanine
(c) valine (d) serine. *(2016)*

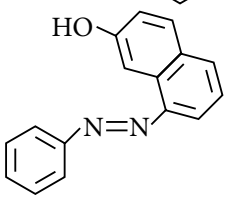
59. In the following reactions, the major product *W* is



(a) 

(b) 

(c) 

(d) 

(2015)

ANSWER KEY

1.	(6)	**2.**	(6)	**3.**	(b, c)	**4.**	(a, c)	**5.**	(8)
6.	(4)	**7.**	(b, c, d)	**8.**	(a, b, c)	**9.**	(c)	**10.**	(c)
11.	(A) → (R and T), (B) → (P, Q and S), (C) → (P, Q and S), (D) → (P, Q, S, and T)								
12.	(a)	**13.**	(b)	**14.**	(b, c)	**15.**	(a, b, d)	**16.**	(d)
17.	(a, b, c)	**18.**	(a)	**19.**	(b)	**20.**	(b)	**21.**	(a, c, d)
22.	(b, d)	**23.**	(6)	**24.**	(b, c)	**25.**	(b)	**26.**	(b)
27.	(5)	**28.**	(a)	**29.**	(4)	**30.**	(3)	**31.**	(6)
32.	(b, d)	**33.**	(5)	**34.**	(b, c, d)	**35.**	(d)	**36.**	(a)
37.	(b)	**38.**	(c)	**39.**	(d)	**40.**	(b, c)	**41.**	(d)
42.	(c)	**43.**	(c)	**44.**	(a)	**45.**	(c)	**46.**	(b, c)
47.	(a, b, c)	**48.**	(a)	**49.**	(c)	**50.**	(a)	**51.**	(a)
52.	(4)	**53.**	(c)	**54.**	(d)	**55.**	(c)	**56.**	(b)
57.	(a)	**58.**	(b)	**59.**	(a)				

JEE Advanced

Exam on 20th May

PRACTICE PAPER 2018

PAPER - I

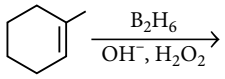
SECTION 1 (MAXIMUM MARKS : 28)

- *This section contains SEVEN questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four options is (are) correct.*
- *For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

Full Marks :	+4	*If only the bubble(s) corresponding to all the correct option(s) is(are) darkened.*
Partial Marks :	+1	*For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened.*
Zero Mark :	0	*If none of the bubbles is darkened.*
Negative Marks :	–2	*In all other cases.*

- *For example, if (a), (c), and (d) are all the correct options for a question, darkening all these three will get +4 marks; darkening only (a) and (d) will get +2 marks; and darkening (a) and (b) will get–2 marks, as a wrong option is also darkened.*

1. Choose the inappropriate statement(s) regarding the following reaction :



(a) Syn addition of –H (from BH_3) and –OH (from solution) occurs.
(b) Syn addition of –H (from BH_3) and –OH (from H_2O_2) occurs.
(c) The product is optically active.
(d) Addition follows anti-Markownikoff's orientation.

2. In a 1st order reaction, amount of the substance left after n half-lives and average life of a 1st order reaction respectively are

(a) $\frac{[A_0]}{2^n}, \frac{1}{k}$ (b) $\frac{[A_0]}{n^2}, \frac{1}{k}$

(c) $\frac{[A_0]}{2^n}, 1.44 \times t_{1/2}$ (d) $\frac{[A_0]}{n^2}, 1.44 \times t_{1/2}$

3. Which of the following statements are correct?
(a) Each atom has at least one orbital, symmetrical about the nucleus.
(b) Each orbit has at least one orbital, symmetrical about the nucleus.
(c) Number of electrons in Ne having their angular momentum equal to zero are four.
(d) Number of waves made by an electron in an orbit is equal to number of orbit.

4. $KMnO_4$ + gas 'B'
H_2O_2 + gas 'B' → Aq. suspension of white solid
Br_2–water + gas 'B'

Aq. suspension of white solid $\xrightarrow[\text{'}P\text{'}]{\text{Reagent}}$ H_2SO_4

Which of the following reagents can be used as 'P'?
(a) O_3 (b) Excess Cl_2 water
(c) Conc. HNO_3 (d) HCl

5. $Na_2C_2O_4 + H_2SO_4 \longrightarrow (A) + Na_2SO_4$

$(A) \xrightarrow{\Delta} H_2O + (X) + (Y)$

(X) → Burns with yellow flame
(Y) → Turns lime water milky

Which of the following reactions will give both gases (X) and (Y)?
(a) $H_2C_2O_4 \xrightarrow{\Delta}$ (b) $FeC_2O_4 \xrightarrow{\Delta}$
(c) $HCOONa \xrightarrow{\Delta}$ (d) $HCOOAg \xrightarrow{\Delta}$

6. Identify the binary mixture(s) that can be separated into individual compounds, by differential extraction, as shown in the given scheme :

Binary mixture containing Compound 1 and Compound 2
- $\xrightarrow{NaOH_{(aq)}}$ Compound 1 + Compound 2
- $\xrightarrow{NaHCO_{3(aq)}}$ Compound 1 + Compound 2

(a) C_6H_5OH and C_6H_5COOH
(b) C_6H_5COOH and $C_6H_5CH_2OH$
(c) $C_6H_5CH_2OH$ and C_6H_5OH
(d) $C_6H_5CH_2OH$ and $C_6H_5CH_2COOH$

7. Which of the following represents the correct order?
(a) Stability : $\overset{+}{C}H_3 < CH_3-\overset{+}{C}H_2 < CH_3-\overset{+}{C}H-CH_3 < (CH_3)_3\overset{+}{C}$
(b) Stability : $\dot{C}H_3 < CH_3-\dot{C}H_2 < CH_3-\dot{C}H-CH_3 < (CH_3)_3\dot{C}$
(c) Hyperconjugation : $CH_3- < CH_3-CH_2- < (CH_3)_2CH- < (CH_3)_3C-$
(d) Basic nature : $\bar{C}H_3 > \bar{N}H_2 > \bar{O}H > \bar{F}$

SECTION 2 (MAXIMUM MARKS : 15)

- *This section contains FIVE questions.*
- *The answer to each question is a SINGLE DIGIT INTEGER ranging from 0 to 9, both inclusive.*
- *For each question, darken the bubble corresponding the correct integer in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

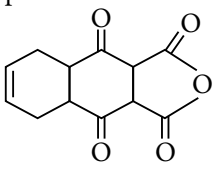
Full Marks : +3 *If only the bubble corresponding to the correct answer is darkened.*
Zero Mark : 0 *In all other cases.*

8. A certain mass of a substance when dissolved in 100 g C_6H_6 lowers the freezing point by 1.28 °C. The same mass of solute dissolved in 100 g of water lowers the freezing point by 1.40 °C. If the substance has normal molecular weight in benzene and is completely dissociated in water, into how many ions does it dissociate in water? (K_f for H_2O and C_6H_6 are 1.86 and 5.12 K mol^{-1} kg respectively.)

9. How many terminal alkynes isomers are possible for the formula C_6H_{10}?

10. How many of the isomeric ketones having the molecular formula $C_6H_{12}O$ undergo iodoform test?

11. The total number of carboxylic acid groups in the product *P* is



12. A tetrapeptide has — COOH group on alanine. This produces glycine (Gly), valine (Val), phenyl alanine (Phe) and alanine (Ala), on complete hydrolysis. For this tetrapeptide, the number of possible sequences (primary structures) with — NH_2 group attached to a chiral center is

SECTION 3 (MAXIMUM MARKS : 18)

- *This section contains SIX questions of matching type.*
- *This section contains TWO tables (each having 3 columns and 4 rows).*
- *Based on each table, there are THREE questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is correct.*
- *For each question, darken the bubble corresponding to the correct option in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

Full Marks : +3 *If only the bubble corresponding to the correct option is darkened.*
Zero Mark : 0 *If none of the bubbles is darkened.*
Negative Marks : –1 *In all other cases.*

Answer Q. 13 to 15 by appropriately matching the information given in the three columns of the following table :
Column 1, 2 and 3 contain group reagents, initial colour of the ppt. and confirmatory tests respectively.

	Column 1		Column 2		Column 3
(I)	H_2S in presence of HCl	(i)	Green ppt.	(P)	Dissolve ppt. in conc. HNO_3 + Ammonium molybdate → Yellow ppt.
(II)	$(NH_4)_2CO_3$ in presence of NH_4OH	(ii)	Black ppt.	(Q)	ppt. + acetic acid + $(NH_4)_2SO_4$ → White ppt.
(III)	H_2S in presence of NH_4OH	(iii)	Yellow ppt.	(R)	ppt. + NaOH + Br_2 water → Yellow solution $\xrightarrow[\text{Lead acetate}]{\text{Acetic acid}}$ Yellow ppt.
(IV)	NH_4OH in presence of NH_4Cl	(iv)	White ppt.	(S)	Dissolve ppt. in aqua regia → Evaporate →Add water + NH_4SCN + acetone → Blue layer

13. The only correct match for the ion formed in the following reaction :
$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow$

(a) (IV) (ii) (Q) (b) (IV) (i) (R)
(c) (III) (ii) (S) (d) (III) (i) (P)

14. The only correct combination for Co^{2+} ion is
(a) (I) (iii) (P) (b) (III) (ii) (Q)
(c) (III) (ii) (S) (d) (I) (iii) (R)

15. This element belongs to *p*-block and its oxide is used as weed killer or an insecticide or for making pyrex glass. The correct match for its ion is
(a) (II) (i) (R) (b) (I) (iii) (P)
(c) (I) (iii) (Q) (d) (II) (i) (S)

Answer Q. 16 to 18 by appropriately matching the information given in the three columns of the following table :

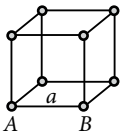
Column 1, 2 and 3 contain relation of atomic radius with edge length, packing efficiency or no. of atoms per unit cell, respectively.

	Column 1		Column 2		Column 3
(I)	$\frac{\sqrt{3}a}{4}$	(i)	52.4%	(P)	2
(II)	$\frac{2a}{\sqrt{3}}$	(ii)	74%	(Q)	1
(III)	$\frac{a}{2}$	(iii)	78%	(R)	3
(IV)	$\frac{a}{2\sqrt{2}}$	(iv)	68%	(S)	4

16. Density of Li atom is 0.53 g/cm^3. The edge length of Li is 3.5 Å. Then the only correct combination for the crystal will be
(a) (II) (iv) (Q) (b) (I) (ii) (P)
(c) (I) (iv) (P) (d) (II) (i) (Q)

17. For a crystal lattice edge length is 400 pm and the diameter of the greatest sphere fitting into the void is 117.08 pm. Then the only correct combination for this crystal lattice will be
(a) (IV) (ii) (S) (b) (III) (ii) (R)
(c) (IV) (iii) (P) (d) (III) (i) (Q)

18. For the given crystal structure correct combination will be
(a) (III) (ii) (P)
(b) (II) (i) (R)
(c) (III) (i) (Q)
(d) (II) (i) (S)



PAPER - II

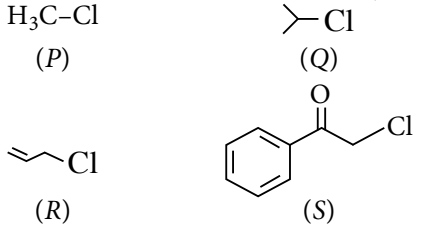
SECTION 1 (Maximum Marks : 21)

- *This section contains SEVEN questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is correct.*
- *For each question, darken the bubble corresponding to the correct option in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

Full Marks : +3 *If only the bubble corresponding to the correct option is darkened.*
Zero Mark : 0 *If none of the bubbles is darkened.*
Negative Marks : –1 *In all other cases.*

1. A certain dye absorbs light of λ = 4530 Å and then fluorescence light of 5080 Å. Assuming that under given conditions 47% of the absorbed energy is re-emitted out as fluorescence, calculate the ratio of quanta emitted out to the no. of quanta absorbed.
(a) 0.901 (b) 0.527 (c) 0.725 (d) 1.09

2. KI in acetone, undergoes S_N2 reaction with each *P*, *Q*, *R* and *S*. The rates of the reaction vary as



(a) $P > Q > R > S$ (b) $S > P > R > Q$
(c) $P > R > Q > S$ (d) $R > P > S > Q$

3. Calculate the amount of polythene formed from 20 kg of calcium carbide from the reactions given below :

$$CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$$

$$HC{\equiv}CH + H_2 \xrightarrow{Pd\text{–}BaSO_4} CH_2{=}CH_2$$

$$n CH_2{=}CH_2 \longrightarrow \underset{\text{Polythene}}{+CH_2-CH_2+_n}$$

(a) 28 g (b) 6 g (c) 9 kg (d) 64 kg

4. $FeCr_2O_4$ (chromite) is converted to Cr by following steps :

$$\text{Chromite} \xrightarrow{I} Na_2CrO_4 \xrightarrow{II} Cr_2O_3 \xrightarrow{III} Cr$$

I, II and III are

	I	II	III
(a)	Na_2CO_3/air, Δ	C	C
(b)	NaOH/air, Δ	C, Δ	Al, Δ
(c)	NaOH/air, Δ	C, Δ	Pb, Δ
(d)	conc. H_2SO_4, Δ	NH_4Cl	C, Δ

5. When equal volumes of the following solutions are mixed, precipitation of AgCl ($K_{sp} = 1.8 \times 10^{-10}$) will occur only with

(a) 10^{-4} M (Ag^+) and 10^{-4} M (Cl^-)
(b) 10^{-5} M (Ag^+) and 10^{-5} M (Cl^-)
(c) 10^{-6} M (Ag^+) and 10^{-6} M (Cl^-)
(d) 10^{-10} M (Ag^+) and 10^{-10} M (Cl^-)

6. S—S bond is present in
(a) $S_2O_7^{2-}$ (b) S_3O_9 (c) $S_2O_4^{2-}$ (d) $S_2O_3^{2-}$

7. Identify the incorrect statement among the following.
(a) Ozone reacts with SO_2 to give SO_3.
(b) Silicon reacts with $NaOH_{(aq)}$ in the presence of air to give Na_2SiO_3 and H_2O.
(c) Cl_2 reacts with excess of NH_3 to give N_2 and HCl.
(d) Br_2 reacts with hot and strong NaOH solution to give NaBr, $NaBrO_4$ and H_2O.

SECTION 2 (MAXIMUM MARKS : 28)

- *This section contains SEVEN questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is(are) correct.*
- *For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

Full Marks :	+4	*If only the bubble(s) corresponding to all the correct option(s) is(are) darkened.*
Partial Marks :	+1	*For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened.*
Zero Mark :	0	*If none of the bubbles is darkened.*
Negative Marks :	–2	*In all other cases.*

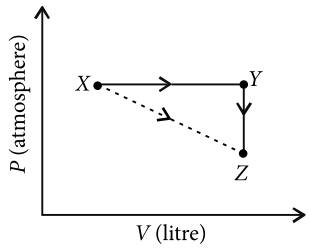
- *For example, if (a), (c), and (d) are all the correct options for a question, darkening all these three will get +4 marks; darkening only (a) and (d) will get +2 marks; and darkening (a) and (b) will get –2 marks, as a wrong option is also darkened.*

8. If T is the time required by electron in taking one round in an orbit, n represents the number of waves in an orbit, r represents the radius of orbit, then which have the value of 1/2 for 2nd orbit of H and 4th orbit of He^+?

(a) $\frac{r_{2(H)}}{r_{4(He^+)}}$ (b) $\frac{T_{2(H)}}{T_{4(He^+)}}$

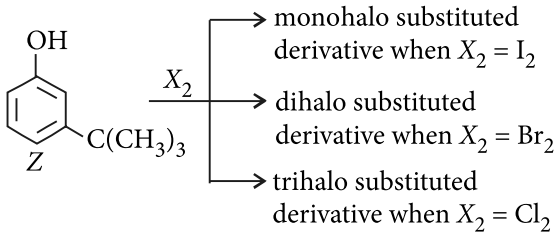
(c) $\frac{n_{2(H)}}{n_{4(He^+)}}$ (d) $\frac{E_{2(H)}}{E_{4(He^+)}}$

9. For an ideal gas, consider only P-V work in going from an initial state X to the final state Z. The final state Z can be reached by either of the two paths shown in the figure. Which of the following choice(s) is(are) correct?



(a) $\Delta S_{X \to Z} = \Delta S_{X \to Y} + \Delta S_{Y \to Z}$
(b) $w_{X \to Z} = w_{X \to Y} + w_{Y \to Z}$
(c) $w_{X \to Y \to Z} = w_{X \to Y}$
(d) $\Delta S_{X \to Y \to Z} = \Delta S_{X \to Y}$

10. The reactivity of compound Z with different halogens under appropriate conditions is given below :



The observed pattern of electrophilic substitution can be explained by
(a) the steric effect of the halogen
(b) the steric effect of the *tert*-butyl group
(c) the electronic effect of the phenolic group
(d) the electronic effect of the *tert*-butyl group.

11. Extraction of metal from the ore cassiterite involves
(a) carbon reduction of an oxide ore
(b) self-reduction of a sulphide ore
(c) removal of copper impurity
(d) removal of iron impurity.

12. For the equilibrium at 298 K : $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$; $G^\circ_{N_2O_4} = 100$ kJ mol^{-1} and $G^\circ_{NO_2} = 50$ kJ mol^{-1}. If 5 moles of N_2O_4 and 2 moles of NO_2 are taken initially in one litre container then which statements are correct?
(a) Reaction proceeds in forward direction
(b) $K_c = 1$
(c) $\Delta G = -0.55$ kJ, $\Delta G^\circ = 0$
(d) At equilibrium $[N_2O_4] = 4.894$ M and $[NO_2] = 2.212$ M

13. At constant temperature, the equilibrium constant (K_p) for the decomposition reaction, $N_2O_4 \rightleftharpoons 2NO_2$ is expressed by $K_p = (4x^2P)/(1 - x^2)$, where P = pressure, x = extent of decomposition. Which one of the following statement(s) is/are true?

(a) K_p increases with increase of P.
(b) K_p increases with increase of x.
(c) K_p increases with decrease of x.
(d) K_p remains constant with change in P and x.

14. For the given aqueous reactions, which of the statement(s) is(are) true?

Excess KI + $K_3[Fe(CN)_6]$ $\xrightarrow{\text{dilute } H_2SO_4}$ brownish-yellow solution $\xrightarrow{ZnSO_4}$ white precipitate + brownish-yellow filtrate $\xrightarrow{Na_2S_2O_3}$ colourless solution

(a) The first reaction is a redox reaction.
(b) White precipitate is $Zn[Fe_3(CN)_6]_2$
(c) Addition of filtrate to starch solution gives blue colour.
(d) White precipitate is soluble in NaOH solution.

SECTION 3 (Maximum Marks : 12)

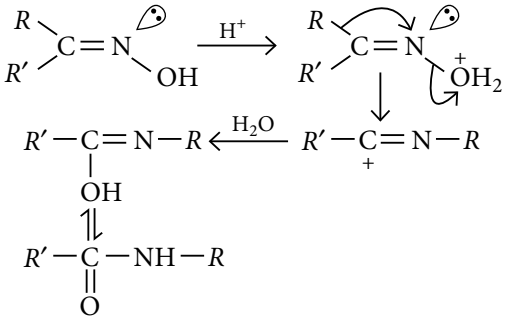
- *This section contains TWO paragraphs.*
- *Based on each paragraph, there are TWO questions.*
- *Each question has Four options (a), (b), (c) and (d). ONLY ONE of these four options is correct.*
- *For each question, darken the bubble corresponding to the correct option in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

Full Marks : +3 *If only the bubble corresponding to the correct option is darkened.*

Zero Mark : 0 *In all other cases.*

Paragraph 1

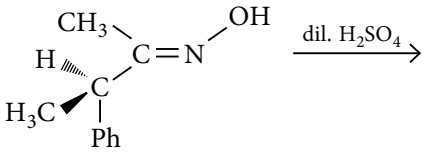
Aldehydes and ketones react with NH_2OH to form aldoximes and ketoximes respectively. Configuration of these can be determined by Beckmann rearrangement as that group migrates which is *anti* w.r.t. –OH.



It is interesting to note that the migration of group is completely retentive and no loss of optical activity is seen.

15. $CH_3CHO + NH_2OH \xrightarrow{\Delta} P \xrightarrow{H^+} Q \xrightarrow{Br_2/KOH} (CH_3NH_2)$ (as only product)
R

Which of the following statements are correct?
(a) Oxime P shows geometrical isomerism.
(b) Q is more basic than R.
(c) Q is $H-\underset{\underset{O}{\|}}{C}-NH-CH_3$
(d) None of these.

16.  (+) dextrorotatory

Which of the following is true about product?
(a) It is also (+) laevorotatory.
(b) Both (+) (–) forms are obtained in equal amount.
(c) It is having '*S*' configuration for chiral carbon.
(d) It is having '*R*' configuration for chiral carbon.

Paragraph 2

Tollens' reagent is used for the detection of aldehyde when a solution of $AgNO_3$ is added to glucose with NH_4OH then gluconic acid is formed.

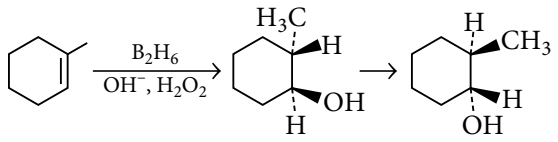
$Ag^+ + e^- \longrightarrow Ag$; $E^\circ_{red} = 0.8$ V
$C_6H_{12}O_6 + H_2O \longrightarrow$ Gluconic acid $(C_6H_{12}O_7) + 2H^+ + 2e^-$; $E^\circ_{oxd} = -0.05$ V
$Ag(NH_3)_2^+ + e^- \longrightarrow Ag_{(s)} + 2NH_3$; $E^\circ_{red} = 0.337$ V
[Given : $2.303 \times \frac{RT}{T} = -0.0591$ and $\frac{F}{RT} = 38.92$ at 298 K]

17. When ammonia is added to the solution, pH is raised to 11. Which half-cell reaction is affected by pH and by how much?
(a) E_{oxd} will increase by a factor of 0.65 from E°_{oxd}.
(b) E_{oxd} will decrease by a factor of 0.65 from E°_{oxd}.
(c) E_{red} will increase by a factor of 0.65 from E°_{red}.
(d) E_{red} will decrease by a factor of 0.65 from E°_{red}.

18. Ammonia is always added in this reaction. Which of the following must be incorrect?
(a) NH_3 combines with Ag^+ to form a complex.
(b) $Ag(NH_3)_2^+$ is a stronger oxidising agent than Ag^+.
(c) In absence of NH_3 silver salt of gluconic acid is formed.
(d) NH_3 has affected the standard reduction potential of glucose/gluconic acid electrode.

PAPER - I

1. (a, c) : –OH comes from H_2O_2,



Enantiomers
(Racemic mixture)

2. (a, c) : Amount of the substance left after one half-life $= \frac{[A_0]}{2}$

Amount of the substance left after two half-lives

$$= \frac{1}{2}\frac{[A_0]}{2} = \frac{[A_0]}{2^2}$$

Amount of substance left after three half-lives

$$= \frac{1}{2} \times \frac{[A_0]}{2^2} = \frac{[A_0]}{2^3}$$

Amount of the substance left after n half-lives $= \frac{[A_0]}{2^n}$

and avg. life $(\tau) = \frac{1}{k} = \frac{t_{1/2}}{0.693} = 1.44 \times t_{1/2}$

3. (a, b, c, d,)

4. (a, b, c) : O_3, Cl_2 water and conc. HNO_3 being strong oxidants will oxidise sulphur (present in aq. suspension of white solid) into H_2SO_4.

5. (a, b) : $Na_2C_2O_4 + H_2SO_4 \longrightarrow \underset{(A)}{H_2C_2O_4} + Na_2SO_4$

$$H_2C_2O_4 \xrightarrow{\Delta} H_2O + \underset{(X)}{CO} + \underset{(Y)}{CO_2}$$

$$FeC_2O_4 \xrightarrow{\Delta} FeO + CO + CO_2$$

$$2HCOONa \xrightarrow{\Delta} Na_2C_2O_4 + H_2$$

$$2HCOOAg \xrightarrow{\Delta} Ag + HCOOH + CO_2$$

6. (b, d) :

(b) $\underset{1}{C_6H_5COOH} + \underset{2}{C_6H_5CH_2OH} \xrightarrow{\text{aq. NaOH}} \underset{+\ 2(\text{insoluble})}{1\ (\text{Soluble})}$

$$\downarrow \text{aq. } NaHCO_3$$

1 (soluble) + 2(insoluble)

(d) $\underset{1}{C_6H_5CH_2OH} + \underset{2}{C_6H_5CH_2COOH} \xrightarrow{\text{aq. NaOH}} \underset{+\ 2(\text{soluble})}{1(\text{insoluble})}$

$$\downarrow \text{aq. } NaHCO_3$$

1(insoluble) + 2(soluble)

7. (a, b, c, d)

8. (3) : $\because \quad \Delta T_f = \frac{1000 \times K_f' \times w}{W \times m}$

In C_6H_6 : $1.28 = \frac{1000 \times 5.12 \times w}{m_N \times 100}$ ...(i)

In H_2O : $1.40 = \frac{1000 \times 1.86 \times w}{m_{exp} \times 100}$ ...(ii)

(Since, given that solute behaves as normal in C_6H_6 and dissociates in water).

By Eqs. (i) and (ii),

$$\frac{m_N}{m_{exp}} = \frac{1.40}{1.28} \times \frac{5.12}{1.86} = 3.01$$

$\therefore \quad i = 3.01 \approx 3.0$

Since, solute is 100% ionised, *i.e.*, $\alpha = 1$;

Let solute be A_xB_y, then

	$A_xB_y \rightleftharpoons$	xA^+	+	yB^-
Moles before dissociation	1	0		0
Moles after dissociation	$(1-\alpha)$	$x\alpha$		$y\alpha$

$\therefore \quad i = 1 - \alpha + x\alpha + y\alpha \quad \because \quad i = 3$ and $\alpha = 1$

$\therefore \quad x + y = 3$

or No. of ions given by solute in water = 3

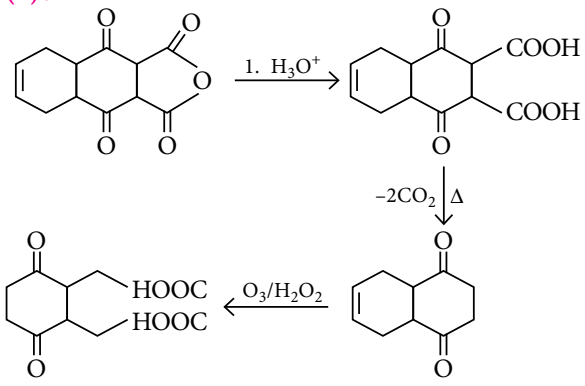
9. (4) : $CH_3CH_2CH_2CH_2C{\equiv}CH$

$(CH_3)_2CHCH_2C{\equiv}CH$, $(CH_3)_3CC{\equiv}CH$

$CH_3CH_2CH(CH_3)C{\equiv}CH$

10. (4) : Four isomeric ketones *i.e.*, $CH_3COCH_2CH_2CH_2CH_3$, $CH_3COCH(CH_3)CH_2CH_3$, $CH_3COCH_2CH(CH_3)_2$ and $CH_3COC(CH_3)_3$ undergo iodoform test.

11. (2) :



12. (4) : Following combinations are possible for tetrapeptide :

Val – Phe – Gly – Ala; Val – Gly – Phe – Ala

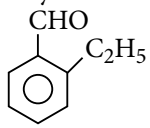
Phe – Gly – Val – Ala; Phe – Val – Gly – Ala

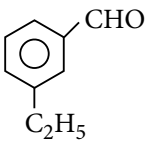
Contd. on P. No. 83

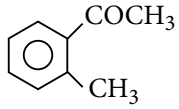
PRACTICE PAPER
AIIMS

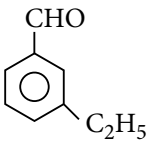
Exam on 26th & 27th May 2018

1. An aromatic compound '*X*' with molecular formula $C_9H_{10}O$ gives the following chemical tests :
(i) forms 2, 4-DNP derivative
(ii) reduces Tollens' reagent
(iii) undergoes Cannizzaro reaction, and
(iv) on vigorous oxidation, 1, 2-benzenedicarboxylic acid is obtained.
Identity the compound *X*.

(a) 

(b) 

(c) 

(d) 

2. An excess of $AgNO_3$ is added to 100 mL of 0.01 M solution of dichlorotetraaquachromium (III) chloride. The number of moles of AgCl precipitated would be
(a) 0.001 (b) 0.002 (c) 0.003 (d) 0.01

3. A certain aqueous solution of $FeCl_3$ (Formula mass = 162) has a density of 1.1 g/mL and contains 20.0% $FeCl_3$. Molar concentration of this solution is
(a) 0.028 M (b) 0.163 M
(c) 1.357 M (d) 1.47 M

4. Which of the following reactions can produce $R-CO-Ar$?
(a) $ArCOCl + H-Ar \xrightarrow{AlCl_3}$
(b) $RCOCl + ArMgX \longrightarrow$
(c) $ArCOCl + RMgX \longrightarrow$
(d) $RCOCl + H-Ar \xrightarrow{AlCl_3}$

5. Ebonite is
(a) natural rubber (b) synthetic rubber
(c) highly vulcanized rubber
(d) polypropene.

6. In the following reaction,
$Cr(OH)_3 + OH^- + IO_3^- \longrightarrow CrO_4^{2-} + H_2O + I^-$
(a) IO_3^- is oxidizing agent
(b) $Cr(OH)_3$ is oxidized
(c) $6e^-$ are being taken per I atom
(d) all are correct.

7. The freezing point of a solution containing 0.2 g of acetic acid in 20.0 g benzene is lowered by 0.45 °C. The degree of association of acetic acid in benzene is (Assume acetic acid dimerises in benzene and K_f for benzene = 5.12 K kg mol^{-1})
(a) 94.5% (b) 54.9% (c) 78.2% (d) 100%

8. A metal crystallises into two cubic phases, face centred cubic (*fcc*) and body centred cubic (*bcc*), whose unit lengths are 3.5 and 3.0 Å, respectively. What will be the ratio of densities of *fcc* to *bcc*?
(a) 1.259 (b) 2.513 (c) 0.892 (d) 1.862

9. Containers *A* and *B* have same gases. Pressure, volume and temperature of *A* are all twice that of *B*, then the ratio of number of molecules of *A* and *B* are
(a) 1 : 2 (b) 2 : 1 (c) 1 : 4 (d) 4 : 1

10. Of the following molecules, the one which has permanent dipole moment is
(a) SiF_4 (b) BF_3 (c) PF_3 (d) PF_5

11. The reaction of $C_6H_5CH=CHCHO$ with $NaBH_4$ gives
(a) $C_6H_5CH_2CH_2CH_2OH$
(b) $C_6H_5CH=CHCH_2OH$
(c) $C_6H_5CH_2CH_2CHO$
(d) $C_6H_5CH_2CHOHCH_3$

12. Bimolecular reduction of acetone gives
(a) diacetoneamine (b) pinacol
(c) chloretone (d) propane.

13. Fraction of total volume occupied by atoms in a simple cubic cell is

(a) $\frac{\pi}{2}$ (b) $\frac{\sqrt{3}\pi}{8}$ (c) $\frac{\sqrt{2}\pi}{6}$ (d) $\frac{\pi}{6}$

14. Which of the following statements is incorrect?
(a) During N_2^+ formation, one electron is removed from the bonding molecular orbital of N_2.
(b) During O_2^+ formation, one electron is removed from the antibonding molecular orbital of O_2.
(c) During O_2^- formation, one electron is added to the bonding molecular orbital of O_2.
(d) During CN^- formation, one-electron is added to the bonding molecular orbital of CN.

15. Which one of the following statements is not true regarding (+) Lactose?
(a) On hydrolysis, (+) Lactose gives equal amount of *D*-(+) glucose and *D*-(+) galactose.
(b) (+) Lactose is a β-glycoside formed by the union of a molecule of *D*-(+) glucose and a molecule of *D*-(+) galactose.
(c) (+) Lactose is a reducing sugar and does not exhibit mutarotation.
(d) (+) Lactose, $C_{12}H_{22}O_{11}$ contains 8-OH groups.

16. Novolac, the linear polymer used in paints is
(a) a copolymer of 1, 3-butadiene and styrene
(b) obtained by the copolymerization of methyl methacrylate
(c) an initial product obtained by the condensation of phenol and formaldehyde
(d) a copolymer of melamine and formaldehyde.

17. Which of the following ions has the least flocculation value?
(a) PO_4^{3-} (b) SO_4^{2-}
(c) $[Fe(CN)_6]^{4-}$ (d) Cl^-

18. The oxidation state of chromium in the final product formed by the reaction between KI and acidified potassium dichromate solution is
(a) +4 (b) +6 (c) +2 (d) +3

19. The order of decreasing ease of reaction with ammonia is
(a) anhydrides, esters, ethers
(b) anhydrides, ethers, ester
(c) ethers, anhydrides, esters
(d) esters, ethers, anhydrides.

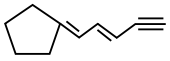
20. Most of the deodorants contain aluminium salts because they
(a) act as antiperspirants
(b) act as antibacterial agents
(c) mask body odour
(d) all of these.

21. There is a sample of 10 volume of hydrogen peroxide solution. Its percent strength is
(a) 3.50% (b) 4.045%
(c) 2.509% (d) 3.035%

22. During estimation of nitrogen present in an organic compound by KJeldahl's method, the ammonia evolved from 0.5 g of the compound in KJeldahl's estimation of nitrogen, neutralised 10 mL of 1 M H_2SO_4. Find out the percentage of nitrogen in the compound.
(a) 56.0% (b) 58.0% (c) 56.5% (d) 58.5%

23. An organic compound '*A*' having molecular formula C_2H_3N on reduction gave another compound '*B*'. Upon treatment with nitrous acid, '*B*' gave ethyl alcohol. On warming with chloroform and alcoholic KOH, *B* forms an offensive smelling compound '*C* '. The compound '*C*' is
(a) $CH_3CH_2NH_2$ (b) $CH_3CH_2N \rightrightarrows C$
(c) $CH_3C{\equiv}N$ (d) CH_3CH_2OH

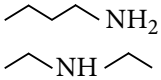
24. The number of *cis-trans* isomers possible for the given compound is



(a) 2 (b) 4 (c) 6 (d) 8

25. The major product obtained in the dehydrohalogenation of *neo*-pentyl bromide with alcoholic KOH is
(a) 2-methylbut-1-ene
(b) 2, 2-dimethylbut-1-ene
(c) 2-methylbut-2-ene
(d) but-2-ene.

26. Among the following compounds, the one(s) that gives (give) effervescence with aquous $NaHCO_3$ solution is (are)
I. $(CH_3CO)_2O$ II. CH_3COOH
III. PhOH IV. CH_3COCHO
(a) I and II (b) I and III
(c) only II (d) I and IV

27. Among the following isomeric amines of molecular formula $C_4H_{11}N$ one having the lowest boiling point is
(a)  (b)
(c)  (d)

28. Chemical formula of 'Red *sindoor*' is
(a) $Pb(NO_3)_2$ (b) Na_2PbO_2
(c) Pb_3O_4 (d) $PbCl_2$

29. The intermediate obtained in the following reaction

$$R-\overset{\overset{O}{\|}}{C}-Cl \xrightarrow[\text{(ii) } ROH]{\text{(i) } NaN_3} \xrightarrow[\text{(iii) } H_3^+O/\Delta]{} RNH_2 \text{ is/are}$$

(a) $R-\overset{\overset{O}{\|}}{C}-\overset{\ddot{}}{\underset{\ddot{}}{N}}-\overset{+}{N}\equiv\ddot{N}$ (b) $R-N=C=O$
(c) both (a) and (b) (d) none of these.

30. Which of the following is isostructural with I_3^- ?
(a) ICl_2^-, XeF_2, N_3^- (b) NO_2^-, XeF_2, N_3^-
(c) NH_2^-, NO_2^-, ICl_2^- (d) BH_3, CO_2, ICl_2^-

31. For the reactions, $A \longrightarrow B$; $k_1 = 10^8 e^{-\frac{6000}{8.34T}}$

and $P \longrightarrow Q$; $k_2 = 10^{10} e^{-\frac{8000}{8.34T}}$

The temperature at which $k_1 = k_2$ is
(a) 386 K (b) 221 K (c) 26 K (d) 52 K

32. Imino acid among these compounds is
(a) serine (b) proline
(c) tyrosine (d) lysine.

33. Which of the following is not an example of green chemistry?
(a) Catalytic dehydrogenation of the diethanol amine without using cyanide and formaldehyde.
(b) Replacement of CFCs by CO_2 as blowing agent in the manufacture of polystyrene foam sheets.
(c) Reacting methylamine and phosgene to produce methyl isocyanate.
(d) Replacement of organotins by 'sea-nine' and as fouling compound in sea marines.

34. If the equilibrium constants of the following equilibria,

$SO_2 + \frac{1}{2}O_2 \rightleftharpoons SO_3$ and $2SO_3 \rightleftharpoons 2SO_2 + O_2$

are given by K_1 and K_2 respectively. Which of the following relations is correct?

(a) $K_2 = \left(\frac{1}{K_1}\right)^2$ (b) $K_1 = \left(\frac{1}{K_2}\right)^3$

(c) $K_2 = \left(\frac{1}{K_1}\right)$ (d) $K_2 = (K_1)^2$

35. $H_2S_{(g)} \longrightarrow HS_{(g)} + H_{(g)}$; $\Delta H^\circ = x_1$,
$\Delta H_f^\circ[H_2S_{(g)}] = x_2$, $\Delta H_f^\circ[H_{(g)}] = x_3$
then, ΔH_f° (HS) is
(a) $x_1 + x_2 - x_3$ (b) $x_3 - x_1 - x_2$
(c) $x_1 - x_2 - x_3$ (d) $x_3 - x_1 + x_2$.

36. Phenolic antibacterial used in body deodorants is
(a) 2, 4-dichlorophenol (b) *p*-chloro-*m*-xylenol
(c) *p*-chlorophenol (d) *p*-nitro-*m*-xylenol.

37. At higher concentration, orthoboric acid exists as polymeric metaborate species. Its anionic form is
(a) $B_2O_4^{2-}$ (b) $[B_2O_4(OH)_4]^{6-}$
(c) $[B_3O_3(OH)_4]^-$ (d) $[B_2O_3(OH)_4]^{2-}$

38. Which of the following reagents can separate nitric oxide from nitrous oxide?
(a) Sodium nitroprusside solution
(b) Ferrous sulphate solution
(c) Nessler's solution (d) Tollens' reagent

39. Knowing that the chemistry of lanthanoids (Ln) is dominated by its +3 oxidation state, which of the following statements is incorrect?
(a) The ionic sizes of Ln (III) generally decrease with increasing atomic number.
(b) Ln (III) compounds are generally colourless.
(c) Ln (III) hydroxides are mainly basic in character.
(d) Because of the large size of the Ln (III) ions, the bonding in its compounds is predominantly ionic in character.

40. In the reaction,

$$CH_3CH_2CH_2NH_2 \xrightarrow[0\text{-}5^\circ C]{NaNO_2 + \text{dil. HCl}} P + N_2.$$

The product (*P*) formed is
(a) $CH_3CH=CH_2$ (b) $CH_3CH_2CH_2OH$
(c) both (a) and (b) (d) none of these.

ASSERTION AND REASON

Directions : In the following questions (41-60), a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

41. **Assertion :** If standard reduction potential for the reaction, $Ag^+ + e^- \rightarrow Ag$ is 0.80 volt, then for the reaction, $2Ag^+ + 2e^- \rightarrow 2Ag$, it will be 1.60 volt.
Reason : If concentration of Ag^+ ions is doubled, its standard electrode potential is also doubled.

42. **Assertion :** PbO_2 is a powerful oxidising agent, it evolves O_2 gas on reaction with conc. H_2SO_4.
Reason : Due to inert pair effect, +2 oxidation state of Pb is the most stable.

43. **Assertion :** Tl^{3+} acts as an oxidising agent.
Reason : Tl^{+} is more stable than Tl^{3+} due to inert pair effect.

44. **Assertion :** $Al(OH)_3$ is amphoteric in nature.
Reason : Al — O and O — H bonds can be broken with equal ease in $Al(OH)_3$.

45. **Assertion :** $[CoF_6]^{3-}$ ion shows magnetic moment corresponding to three unpaired electrons.
Reason : It undergoes d^2sp^3-hybridisation.

46. **Assertion :** The mobility of sodium ion is lower than that of potassium ion in aqueous solution.
Reason : The ionic mobility depends upon the radius of the hydrated ion.

47. **Assertion :** Ionic radii of Ta and Nb are same.
Reason : The lanthanide contraction cancels almost exactly the normal size increase on descending a group of transition elements.

48. **Assertion :** When KI solution is added to $AgNO_3$ solution, negatively charged sol results.
Reason : It is due to preferential adsorption of iodide ions from the dispersion medium.

49. **Assertion :** The thermal stability of hydrides of carbon family is in order :
$CH_4 > SiH_4 > GeH_4 > SnH_4 > PbH_4$
Reason : E – H bond dissociation enthalpies of the hydrides of carbon family decrease down the group with increasing atomic size.

50. **Assertion :** Esters which contain α-hydrogens undergo Claisen condensation.
Reason : $LiAlH_4$ reduction of esters gives acids.

51. **Assertion :** *trans*-Pent-2-ene is polar but *trans*-but-2-ene is non-polar.
Reason : The polarity of *cis*-isomer is more than *trans*-isomer.

52. **Assertion :** For the Daniell cell,
$Zn \mid Zn^{2+} \parallel Cu^{2+} \mid Cu$ with E_{cell} = 1.1 V, the application of opposite potential greater than 1.1 V results into the flow of electrons from cathode to anode.
Reason : Zinc is deposited at anode and Cu is dissolved at cathode.

53. **Assertion :** Froth floatation process is based on the different wetting nature of ore and gangue particles.
Reason : Mustard oil is used as frother in froth floatation process.

54. **Assertion :** When CO_2 is passed through an aqueous solution of sodium picrate, picric acid gets precipitated.
Reason : Carbonic acid is stronger acid that picric acid.

55. **Assertion :** If an electron is in 4*p*-orbital, then possible values of quantum numbers are $n = 4$, $l = 1$, $m = 0, \pm1$, and $s = \pm\frac{1}{2}$.
Reason : The second shell is a combination of one *s*, one *p* and one *d*-subshell.

56. **Assertion :** On dilution, the equivalent as well as molar conductivity of solution increases.
Reason : With dilution, the number of current carrying particles per cm^3 increases.

57. **Assertion :** The second ionization energies of ^{23}V, ^{24}Cr and ^{25}Mn are in the order V < Cr < Mn.
Reason : Ionization energies show a regular increase along a period with increase of atomic number.

58. **Assertion :** 10,000 molecules of CO_2 have the same volume at STP as 10,000 molecules of CO at STP.
Reason : Both CO and CO_2 are formed by combustion of carbon in presence of oxygen.

59. **Assertion :** $(CH_3)_3C$ — Br and CH_3CH_2ONa react to form $(CH_3)_3C - O - CH_2CH_3$.
Reason : Good yields of ethers are obtained when *tert*-alkyl halide are treated with alkoxides.

60. **Assertion :** Cycloalkenes decolourise the purple colour of dilute and cold $KMnO_4$ and red colour of bromine in carbon tetrachloride.
Reason : Cycloalkenes undergo the electrophilic addition reactions which are characteristic of alkenes.

SOLUTIONS

1. **(a) :** Since compound '*X*' forms 2, 4-DNP, so it must be an aldehyde or a ketone. Since, it reduces Tollens' reagent, it must be an aldehyde. Since, on oxidation it gives 1, 2-benzenedicarboxylic acid, it must be an *o*-alkyl substituted benzaldehyde. Thus, the compound is *o*-ethylbenzaldehyde.

2. **(a) :** The complex is $[Cr(H_2O)_4Cl_2]Cl$. It ionises as :

$$\underset{\text{1 mole}}{[Cr(H_2O)_4Cl_2]Cl} \rightleftharpoons \underset{\text{1 mole}}{[Cr(H_2O)_4Cl_2]^{+}} + Cl^{-}$$

Thus, 1 mole of the complex produces 1 mole of Cl^- ions and hence will precipitate out 1 mole of AgCl.
Now, 100 mL of 0.01 M complex solution contains moles of $Cl^- = \frac{0.01}{1000}\times 100 = 0.001$ mole and will precipitate out 0.001 mole of AgCl.

3. (c) : 20% $FeCl_3$ solution means 100 g of solution contains 20 g of $FeCl_3$.

$\therefore$ Volume of 100 g solution $= \frac{100\text{ g}}{1.1\text{ g/mL}} = 90.91$ mL

Moles of 20 g of $FeCl_3 = \frac{20}{162} = 0.1234$ mole

$\therefore$ Molar concentration of solution

$$= \frac{0.1234}{90.91}\times 1000 = 1.357\text{ M}$$

4. (d) : ArCO*R* can be prepared by the combination of ArH + *R*COCl and not by ArCOCl + *R*Mg*X* because here the ArCO*R* formed will further react with *R*Mg*X* to form 3° alcohol, $ArC(OH)R_2$ as the final products.

$$R\text{COCl} + \text{H}-\text{Ar} \xrightarrow{\text{Anyhd. } AlCl_3} \underset{\text{Aromatic Ketone}}{R-\text{CO}-\text{Ar}} + \text{HCl}$$

5. (c) : Ebonite is a hard highly vulcanized rubber, containing 20-25% sulphur.

6. (d)

7. (a) : Given : $w_2 = 0.2$ g, $w_1 = 20$ g, $\Delta T_f = 0.45$ °C

$$\Delta T_f = \frac{1000\times K_f\times w_2}{w_1\times M} \Rightarrow 0.45 = \frac{1000\times 5.12\times 0.2}{20\times M}$$

$\therefore$ $M_{(\text{observed})} = 113.78$ (acetic acid)

As acetic acid is dimerises in benzene, so,

$$\underset{\begin{matrix}\text{Before association}\\ \text{After association}\end{matrix}}{\begin{matrix}2CH_3COOH & \rightleftharpoons & (CH_3COOH)_2\\ 1 & & 0\\ 1-\alpha & & \alpha/2\end{matrix}}$$

(where α is degree of association)

Molecular weight of acetic acid = 60

$$i = \frac{\text{Normal molecular mass}}{\text{Observed molecular mass}}$$

$$\therefore \quad \frac{M_{(\text{normal})}}{M_{(\text{observed})}} = 1-\alpha+\frac{\alpha}{2}$$

or, $\frac{60}{113.78} = 1-\alpha+\frac{\alpha}{2}$ $\quad\therefore\quad \alpha = 0.945$ or 94.5%

8. (a) : Density of *fcc* $= \frac{Z_1\times \text{At. mass}}{N_A\times a_1^3}$ ...(i)

Density of *bcc* $= \frac{Z_2\times \text{At. mass}}{N_A\times a_2^3}$ ...(ii)

On dividing eqn. (i) to (ii), we get,

$$\frac{d_{fcc}}{d_{bcc}} = \frac{Z_1}{Z_2}\times\frac{a_2^3}{a_1^3}$$

For *fcc*, $Z_1 = 4$; $a_1^3 = (3.5\times 10^{-8})^3$

For *bcc*, $Z_2 = 2$; $a_2^3 = (3.0\times 10^{-8})^3$

$$\frac{d_{fcc}}{d_{bcc}} = \frac{4\times(3\times 10^{-8})^3}{2\times(3.5\times 10^{-8})^3} = 1.259$$

9. (b) : For gas *A*,

$P_1 = 2P$, $V_1 = 2V$, $T_2 = 2T$

For gas *B*,

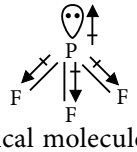
$P_2 = P$, $V_2 = V$, $T_2 = T$

According to ideal gas equation,

$$\frac{P_1V_1}{n_1RT_1} = \frac{P_2V_2}{n_2RT_2}$$

$$\frac{2P\times 2V}{n_1R\times 2T} = \frac{P\times V}{n_2RT}$$

$$\frac{2}{n_1} = \frac{1}{n_2}\ ;\ \frac{n_1}{n_2} = 2:1$$

10. (c) : 

$\mu \neq 0$ but SiF_4, BF_3 and PF_5 are symmetrical molecules thus, $\mu = 0$.

11. (a) : Normally $NaBH_4$ as well as $LiAlH_4$ reduce only $-$CHO group without affecting carbon-carbon double bond, however when it is present in conjugation with benzene ring and aldehydic group, it is also reduced along with the reduction of $-$CHO group.

$$C_6H_5CH=CHCHO \xrightarrow{NaBH_4} C_6H_5CH_2CH_2CH_2OH$$

12. (b) :

$$\underset{\text{Acetone}}{2(CH_3)_2C=O} \xrightarrow[-Mg(OH)_2]{Mg/H_2O} \underset{\begin{matrix}\text{2, 3-dimethylbutane-2,}\\ \text{3-diol (pinacol)}\end{matrix}}{\overset{\overset{OH}{|}\quad\overset{OH}{|}}{(CH_3)_2C-C(CH_3)_2}}$$

Since, two molecules are reduced to form a single compound, it is known as bimolecular reduction.

13. (d) : In simple cubic arrangement,

no. of atoms per unit cell $= \frac{1}{8}\times 8 = 1$; $a = 2r$

$\therefore$ Packing fraction

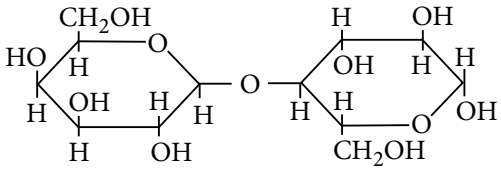
$$= \frac{\text{Volume occupied by one atom}}{\text{Volume of the unit cell}}$$

$$= \frac{\frac{4}{3}\pi r^3}{a^3} = \frac{\frac{4}{3}\pi r^3}{(2r)^3} = \frac{\pi}{6}$$

14. (c) : O_2 : $(\sigma 1s)^2\ (\sigma^* 1s)^2\ (\sigma 2s)^2\ (\sigma^* 2s)^2\ (\sigma 2p_z)^2\ (\pi 2p_x^2 = \pi 2p_y^2)\ (\pi^* 2p_x^1 = \pi^* 2p_y^1)$

O_2^- : $(\sigma 1s)^2\ (\sigma^* 1s)^2 (\sigma 2s)^2\ (\sigma^* 2s)^2 (\sigma 2p_z)^2\ (\pi 2p_x^2 = \pi 2p_y^2)$ $= (\pi^* 2p_x^2 = \pi^* 2p_y^1)$

15. (c) :



(Lactose)

All reducing sugar shows mutarotation.

16. (c)

17. (c) : $[Fe(CN)_6]^{4-}$ has the highest charge therefore, it has minimum flocculation value.

18. (d) : $K_2Cr_2O_7 + 6KI + 7H_2SO_4 \rightarrow 4K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3I_2$

Oxidation state of Cr in $Cr_2(SO_4)_3$:

$2x - 6 = 0$

$\therefore \quad x = +3$

19. (a) : On the basis of electronegativities of the group attached to the carbonyl carbon, the reactivity follows the order : Acid chloride > acid anhydride > acid ester > acid amide. Ether is almost unreactive.

20. (b) : Aluminium salts present in deodorants act as antibacterial agents.

21. (d) : $[H_2O_2 \longrightarrow H_2O + \frac{1}{2}O_2] \times 2$

$2H_2O_2 \longrightarrow 2H_2O + O_2$

22.4 litre at N.T.P.

$\because$ 22.4 litre O_2 at N.T.P. obtained by 68 g of H_2O_2

$\therefore$ 10 litre O_2 at N.T.P. obtained by $\frac{68}{22.4} \times 10$

$= 30.35$ g of H_2O_2

Now, 1000 mL of H_2O_2 solution contain $H_2O_2 = 30.35$ g

$\therefore$ 100 mL of H_2O_2 solution contain H_2O_2

$= \frac{30.35}{1000} \times 100 = 3.035\%$

22. (a) : 1 M of 10 mL H_2SO_4 = 1 M of 20 mL NH_3

Now, 1000 mL of 1 M ammonia contains 14 g nitrogen.

20 mL of 1M ammonia contains $= \frac{14 \times 20}{1000}$ g nitrogen

$\therefore$ Percentage of nitrogen $= \frac{14 \times 20 \times 100}{1000 \times 0.5} = 56.0\%$

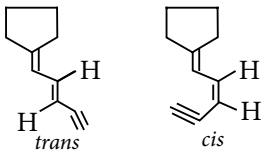
23. (b) : $\underset{(C_2H_3N)}{A} \xrightarrow{\text{reduction}} B \xrightarrow{HNO_2} C_2H_5OH$

$B \xrightarrow[\text{reaction}]{\text{Carbylamine}} \text{Offensive smell } (C)$

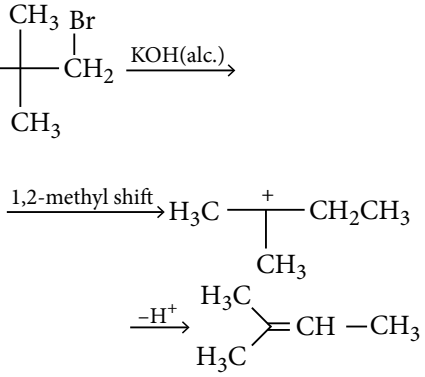
Given reactions indicate that B has 1°–NH_2 group and thus A, C_2H_3N, should be $CH_3C \equiv N$. Hence, C should be CH_3CH_2NC because of its fouling smell.

$\underset{(A)}{CH_3C{\equiv}N} \xrightarrow{\text{Reduction}} \underset{(B)}{CH_3CH_2NH_2} \xrightarrow[KOH]{CHCl_3} \underset{(C)}{CH_3CH_2N{\overset{\rightarrow}{=}}C}$

24. (a) : Triple bond does not show geometrical isomerism. Only one double bond in the given compound will show geometrical isomerism.



25. (c) :



26. (a) : $(CH_3CO)_2O$ reacts with H_2O to produce acetic acid (CH_3COOH). Thus, both $(CH_3CO)_2O$ and CH_3COOH give effervescence with an aqueous solution of $NaHCO_3$.

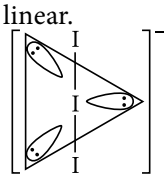
27. (d) : Tertiary amines have low boiling points due to absence of hydrogen bonding.

28. (c)

29. (c) : $R-\overset{O}{\overset{\|}{C}}-Cl + NaN_3 \longrightarrow R-\overset{O}{\overset{\|}{C}}-\overset{-}{\underset{\cdot\cdot}{N}}-\overset{+}{N}\equiv\ddot{N}$

$\xrightarrow[-N_2]{ROH} R-N=C=O \xrightarrow[H_3^+O/\Delta]{ROH} R-NH_2$

30. (a) : I_3^- ion is linear.



ICl_2^-, XeF_2 and N_3^- ions are also linear.

31. (d) : $k_1 = k_2$

$10^8 \, e^{-\frac{6000}{8.34T}} = 10^{10} \, e^{-\frac{8000}{8.34T}}$

$\frac{10^{10}}{10^8} = e^{\frac{2000}{8.34T}}$

$\Rightarrow \quad 2.303 \log 100 = \frac{2000}{8.34\,T} \Rightarrow T = \frac{2000}{2.303 \times 2 \times 8.34} = 52\,K$

32. (b) : Proline contains imino (secondary amino) $>NH$ group, hence it is an imino acid.

33. (c) : Reaction of methylamine and phosgene to produce MIC (methyl isocyanate) is not an example of green chemistry.

34. (a) : $SO_2 + \frac{1}{2}O_2 \rightleftharpoons SO_3$

$$K_1 = \frac{[SO_3]}{[SO_2][O_2]^{1/2}} \quad ...(i)$$

$2SO_3 \rightleftharpoons 2SO_2 + O_2$

$$\text{Thus, } K_2 = \frac{[SO_2]^2[O_2]}{[SO_3]^2} \quad ...(ii)$$

From eqn (i) and (ii), we get

$$\Rightarrow \quad K_2 = \frac{1}{K_1^2} \quad \text{or} \quad K_2 = \left(\frac{1}{K_1}\right)^2$$

35. (a) : $\Delta H^\circ = \Delta H_f^\circ$ (products) – ΔH° (reactants)

$\Delta H^\circ = \Delta H_f^\circ(HS) + \Delta H_f^\circ(H) - \Delta H_f^\circ(H_2S)$

$x_1 = x + x_3 - x_2$

$x = x_1 + x_2 - x_3$

36. (b) : *p*-Chloro-*m*-xylenol is phenolic antibacterial deodorant.

37. (c) : $3B(OH)_3 \rightleftharpoons \underset{\text{Orthoboric acid}}{H_3O^+} + \underset{\text{Polymeric metaborate}}{[B_3O_3(OH)_4]^-} + H_2O$

38. (b)

39. (b) : Ln (III) compounds are generally coloured due to partly filled *f*-orbitals which permit *f*–*f* transition.

40. (b) : $CH_3CH_2CH_2NH_2 \xrightarrow[0\text{-}5^\circ C]{NaNO_2 + \text{dil.HCl}} \underset{(P)}{CH_3CH_2CH_2OH} + N_2$

41. (d) : Standard reduction potential of an electrode has a fixed value and does not affected by concentration.

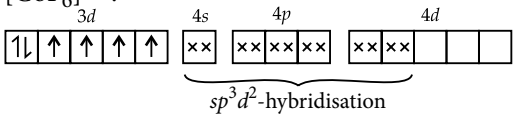
42. (a) **43. (a)** **44. (a)**

45. (d) : $[CoF_6]^{3-}$: $x - 6 = -3 \Rightarrow x = +3$

$Co^{3+}(3d^6)$: 

F^- ion is a weak field ligand and does not cause pairing of electrons.

$[CoF_6]^{3-}$:



$[CoF_6]^{3-}$ ion is highly paramagnetic in nature and magnetic moment corresponds to four unpaired electrons.

46. (a) **47. (a)**

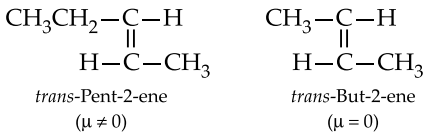
48. (d) : When KI solution is added to $AgNO_3$ solution, positively charged sol results due to adsorption of Ag^+ ions from dispersion medium.

When $AgNO_3$ solution is added to KI solution, the precipitated silver iodide adsorbs iodide ions from the dispersion medium and negatively charged sol results.

49. (a)

50. (c) : On hydrolysis of esters, acids are formed.

51. (b) : The vector sum of all polar bonds in *trans*- pent-2-ene, is not zero while in *trans*-but-2-ene it is zero.



52. (b) : On applying external voltage greater than 1.1 V in the Daniell cell, current flows in the reverse direction, *i.e.*, electrons flow from cathode (Cu^{2+}/Cu) to anode (Zn/Zn^{2+}). The reverse reaction takes place as, $Zn^{2+} + Cu \longrightarrow Zn + Cu^{2+}$

53. (c) : Pine oil is used as frother which wets ore particles whereas gangue particles are wetted by water.

54. (d)

55. (c) : Second shell ($n = 2$) is a combination of one *s*- and one *p*-subshell, but it does not contain *d*-subshell.

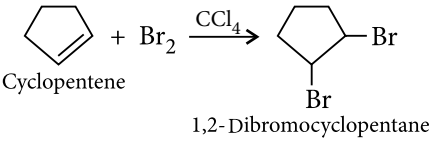
56. (c) : On dilution, the number of current carrying particles per cm^3 decreases (and hence specific conductivity decreases). $\wedge_{eq}$ and $\wedge_m$ increases because increase in volume of the solution is much more than decrease in specific conductivity as,

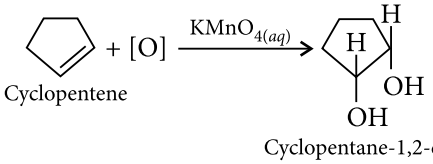
$\wedge_{eq}$ = *sp.* conductivity × volume.

57. (d) : The correct order of second *I.E.* is $^{23}V < {}^{25}Mn < {}^{24}Cr$. Cr after losing one electron has half filled stable configuration $3d^5$ from which removal of second electron is difficult.

58. (b) : Equal number of molecules have same volume at STP because 22400 cc of any gas at STP has Avogadro's number of molecules.

59. (d) : $(CH_3)_3CONa$ and CH_3CH_2Br react to form $(CH_3)_3C - O - CH_2CH_3$ because good yields of ethers are obtained when primary alkyl halides are treated with bulkier alkoxide.

60. (a) : 



Both the reactions are electrophilic addition reactions of alkenes.

ADVANCED CHEMISTRY BLOC

(THERMAL DECOMPOSITION)

Mukul C. Ray, Odisha

Temperature, relative humidity, pressure and chemical constituents all exert a modifying influence on the compounds. They just try to adapt to new conditions just like living beings. Stability plays a key role, after all steps move towards more stable state in thermodynamic sense. In this context, thermal decomposition is a significant area, both in organic and inorganic chemistry.

Be^{2+} ion has very high polarising power. It polarises CO_3^{2-} ion to such an extent that $BeCO_3$ has high degree of covalent character or low lattice energy. On the other hand, BeO has high lattice energy owing to small sized ions. This difference in lattice energy between $BeCO_3$ and BeO acts as the driving force in their thermal decomposition. Practically, $BeCO_3$ decomposes even under room temperature. It appears as if $BeCO_3$ is eager to move towards BeO, which has higher lattice energy.

Thermal stability of group-2 carbonates changes as :

$BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$

In a similar way, you easily understand the following observations :

- Thermal stability of group-1 carbonates :
  $Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$
  Na_2CO_3 is stable to even red heat.
- Thermal stability of group-1 hydroxides :
  $LiOH \xrightarrow{\Delta} Li_2O + H_2O$
  NaOH is stable to heat.

Similarly, thermal stability of hydroxides increases as for group-2 :

$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$

Decomposition is also observed in nitrates :

$$LiNO_3 \xrightarrow{\Delta} Li_2O + NO_2 + O_2$$
$$NaNO_3 \xrightarrow{\Delta} NaNO_2 + O_2$$

A possible explanation can be : Li_2O has high lattice energy but Na_2O is thermally less stable. Poor thermal stability of Na_2O is also reflected in the reaction :

$$Na_2O \xrightarrow{\Delta} Na_2O_2 + Na$$

This is also the reason why on heating in air Na forms Na_2O_2 but Li forms Li_2O.

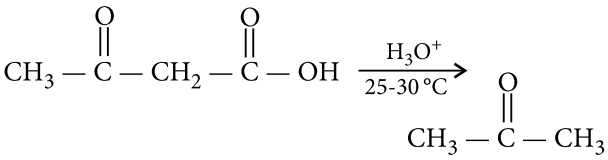
$Mg(NO_3)_2$ and $Pb(NO_3)_2$ behave like $LiNO_3$, $Be(NO_3)_2$ however, on heating at 125 °C forms basic beryllium nitrate.

$$Be(NO_3)_2 \xrightarrow{\Delta} [Be_4O(NO_3)_6]$$

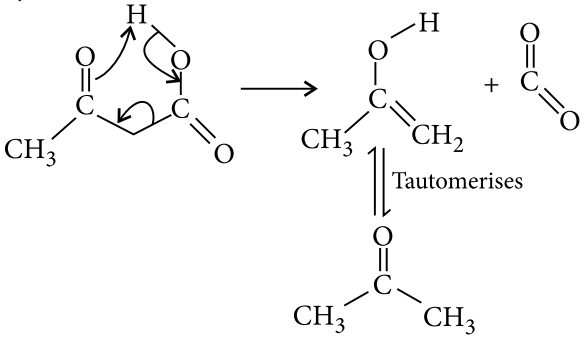
Complexing ability of Be is responsible for this pattern.

Thermal decomposition in organic compounds are also very common, particularly in carboxylic acids.

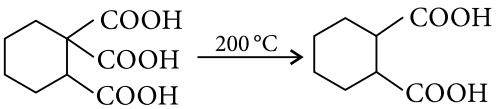
β-keto acids undergo decomposition in acidic medium even at 25-30 °C.

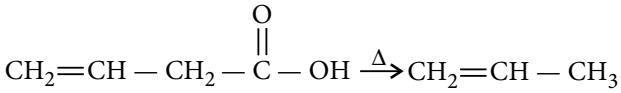


The compound, however, resists thermal decomposition in basic medium. This implies presence of acidic proton is necessary for the decomposition, which involves a cyclic transition state.

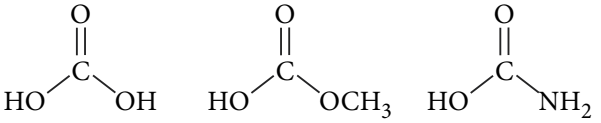


β-diacids, β-cyano acids, β, γ-unsaturated acids also undergo similar decomposition.



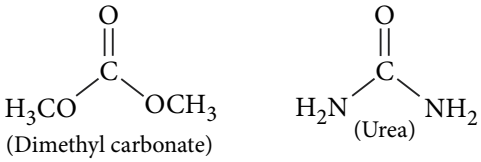


There are few compounds, which undergo spontaneous decompositions. You prepare them and they just decompose. Following are three such compounds. Carbonic acid is a very common example.



There is one thing common : An acid functional group whose –CO– is also a part of another acid or acid derivative functional group.

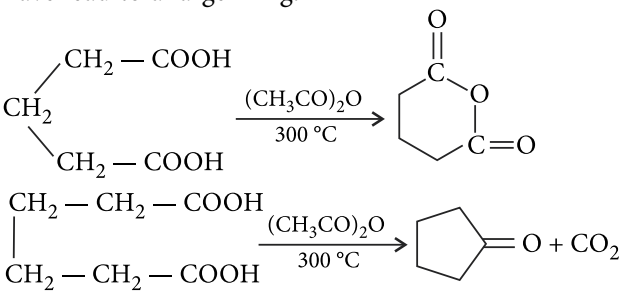
When you have two acid derivative functional groups, sharing one –CO– group, the compound is thermally stable. Examples are :



(Dimethyl carbonate) (Urea)

In all the above decomposition reactions, formation of CO_2 is the driving force.

1, 5-dicarboxylic acid when heated to 300 °C in presence of acetic anhydride gives cyclic anhydride. Under similar conditions 1,6-dicarboxylic acid prefers to give cyclic ketone, probably because formation of anhydride would have lead to a larger ring.



Many such thermal decompositions are part of your syllabus.

$NH_4Cl \xrightarrow{\Delta} NH_3 + HCl$; $PtCl_4 \xrightarrow{\Delta} Pt + Cl_2$

$Ag_2O \xrightarrow{\Delta} Ag + O_2$; $HgO \xrightarrow{\Delta} Hg + O_2$

$Ni(CO)_4 \xrightarrow{\Delta} Ni + CO$ (Mond's process)

$TiI_4 \xrightarrow{\Delta} Ti + I_2$ (Van-Arkel method)

$KMnO_4 \xrightarrow{\Delta} K_2MnO_4 + MnO_2 + O_2$

$K_2Cr_2O_7 \xrightarrow{\Delta} K_2CrO_4 + Cr_2O_3 + O_2$

Never hesitate to remember these reactions. Studying chemistry is like maintaining a delicate balance between informations and concepts.

CONCEPT BOOSTER

Hello! This is my immense pleasure to present this article which is completely based on some minute details of ORGANIC REAGENTS controlling the mechanism of ORGANIC CHEMISTRY. It is my long teaching experience that has enabled me to understand the necessity of the functions of these reagents as per competitive examinations are concerned. Keep practicing and all the best for the examinations.

*Arunava Sarkar

A FEW SELECTIVE REDUCING AGENTS

Maximum of these reagents we have discussed earlier. Here, we are trying to cluster all the reagents with their functions and mechanisms.

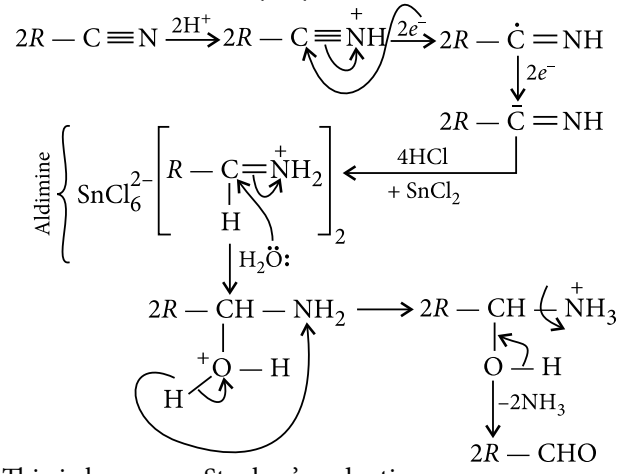
$SnCl_2 + HCl$

It is a milder reducing agent.

$$SnCl_2 + 2HCl \rightarrow SnCl_4 + 2H^+ + 2e^-$$

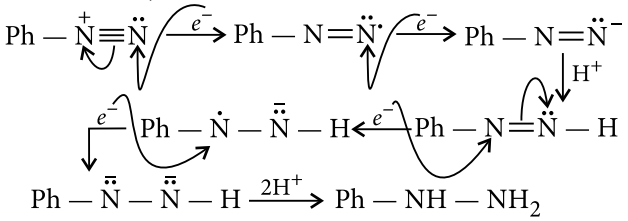
Two very important reactions under this reagent :

❍ **Reaction with alkyl cyanide ($R-C\equiv N$) :**



This is known as Stephen's reduction.

❍ **Reaction with diazonium salt (Benzene diazonium chloride) :**



$TiCl_3 + H_2O$

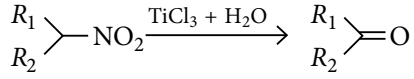
This is an electron transfer reagent.

Comparatively, milder and selective reducing agent.

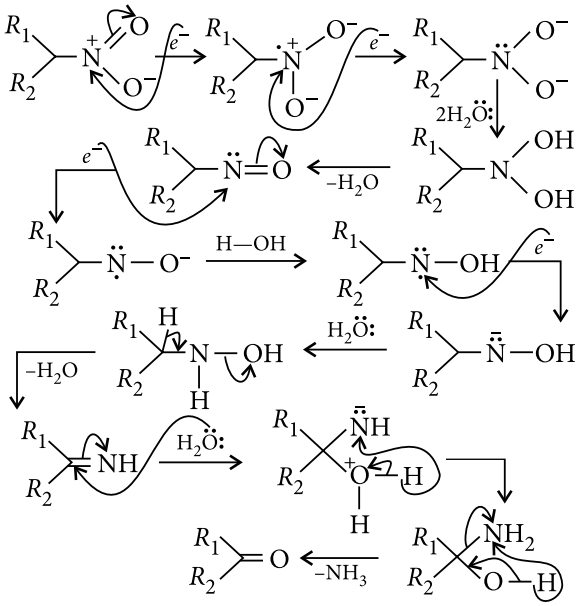
$$Ti^{3+} \rightarrow Ti^{4+} + e^-$$

Some most famous reactions shown by this reducing agent are as below :

❍ **Reduction of nitro group :**



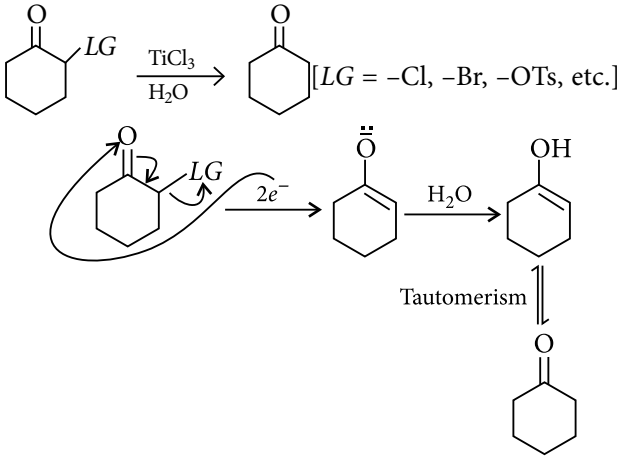
Mechanism :



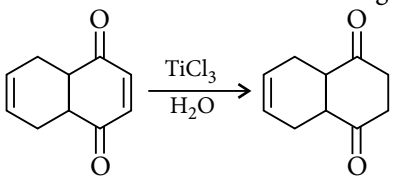
Overall this reaction is called to be reductive hydrolysis.

*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

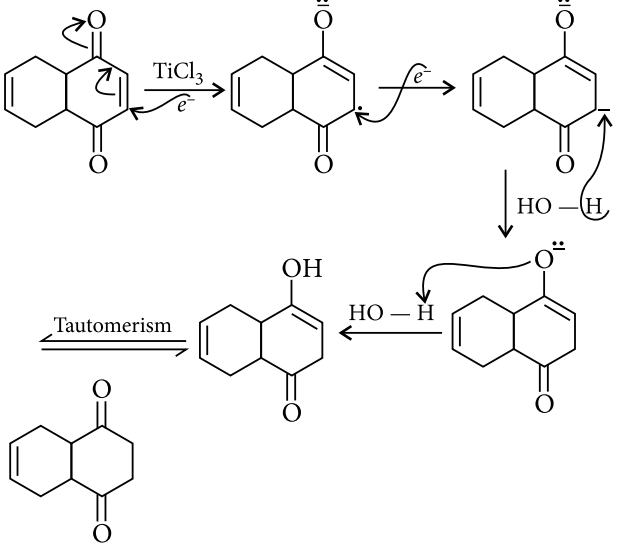
- There is another example which is known as reductive elimination.



- **Selective reduction :** The best example of this category is selective reduction of a particular *ene* of the diene-dione or selective reduction of *ene* of the ene-dione. Let us take the following example :



Mechanism :

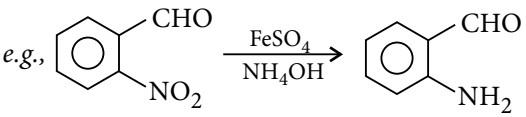


$FeSO_4 + NH_4OH$

This is a milder and selective electron transfer reducing agent.

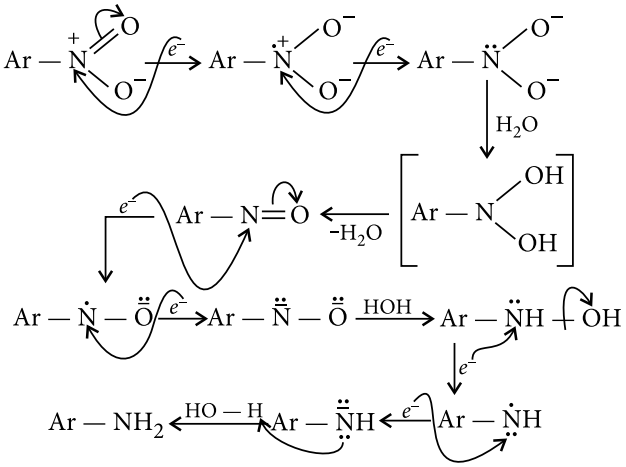
Working medium → Basic medium

- Selective reduction of aromatic nitro group to the aromatic amino group in presence of the other reducible groups.



$Fe^{2+} \longrightarrow Fe^{3+} + e^-$

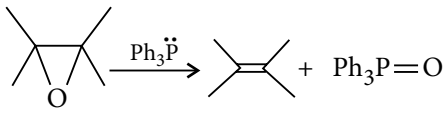
This electron transfer will reduce the nitro group preferably.



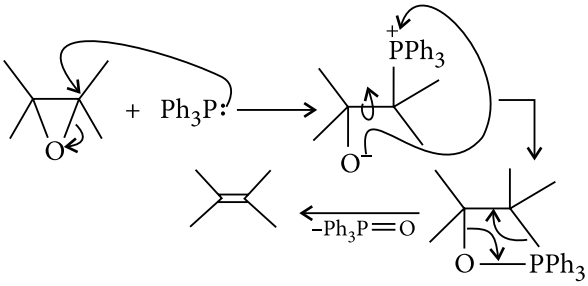
Phosphine Derivatives : Ph_3P and $(EtO)_3P$

We have seen the better use of Ph_3P : In Wittig reaction. It converts the carbonyl group into an alkene moiety. Some of the important reactions are as below :

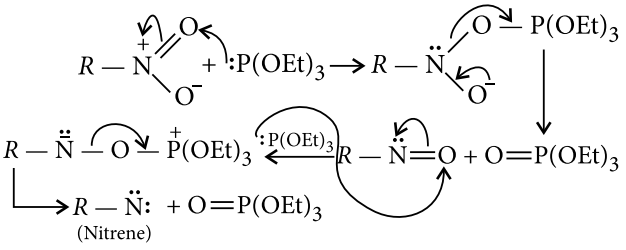
- **Conversion of epoxide to alkene :**



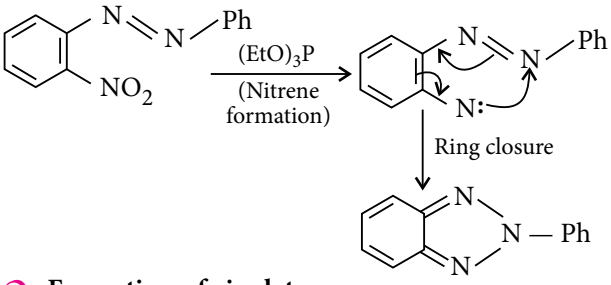
Mechanism :



- **Formation of Nitrene :** From nitro compound.

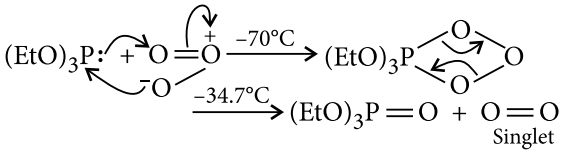


Now, this nitrene can be used for ring closure purposes in many cases. For example :



❍ **Formation of singlet oxygen :**

Triplet oxygen is $\cdot\ddot{O} - \ddot{O}\cdot$ represented by $^3O_2$. Singlet oxygen is $\ddot{O}=\ddot{O}$ represented by $^1O_2$. Singlet oxygen (which is required in Diels-Alder and other reactions) can be prepared by the treatment of $(EtO)_3P$ with O_3.



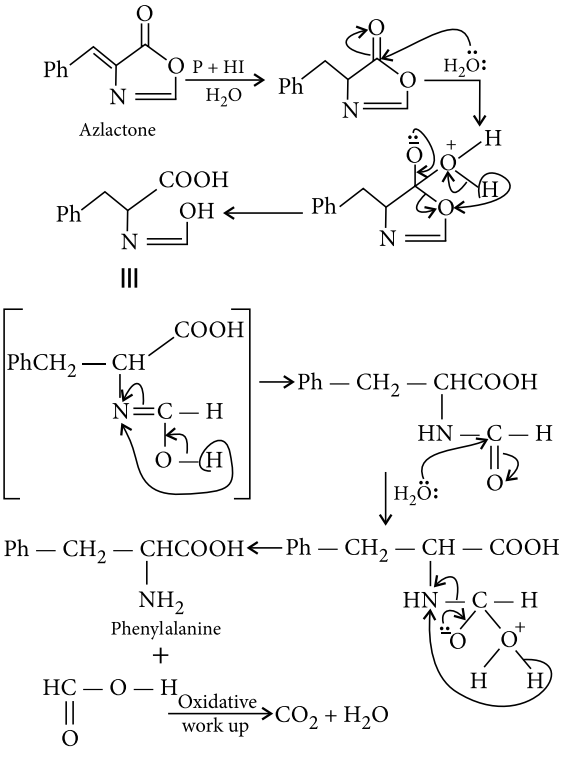
P + HI + H_2O and P + I_2 + CH_3COOH

It is a very useful reagent usually used for the following purposes :

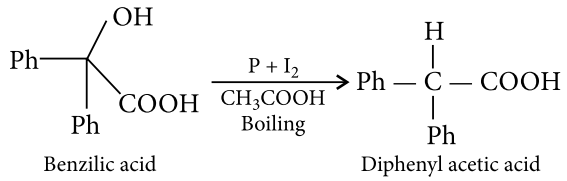
(1) Hydrogenolysis of alcoholic hydroxyl group.

(2) Hydrogenation of $\diagdown C=C \diagup$ which is α(alpha) to the carbonyl group. This is one of the best methods for the preparation of α-amino acids. Some common examples are :

❍



❍



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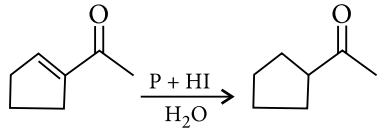


$LiAlH_4$ and $NaBH_4$

$LiAlH_4$ and $NaBH_4$ and their comparative study :

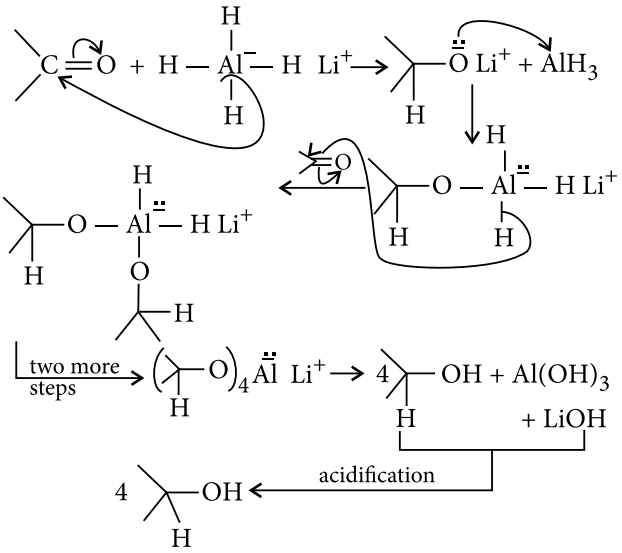
Both these reagents follow similar mechanism for reduction and that is 'hydride' transfer mode of preparation of both the reagents is also similar.

$$LiH + AlH_3 \longrightarrow \overset{+}{Li}\overset{-}{AlH_4}$$

$$NaH + BH_3 \longrightarrow \overset{+}{Na}\overset{-}{BH_4}$$

Reduction is carried out by the anionic part and therefore it is understandable that these attacking parts are nucleophilic and hence the attack is usually carried out to the polarised multiple bonds like $\diagdown C=O$, $-C\equiv O$, $-N=O$, $-C=N-$, etc. The funda is hydride transfer takes place to the more positive atom. This is the sole reason why $LiAlH_4$ and $NaBH_4$ cannot reduce non-polarised multiple bond.

Now, though I have discussed the mechanism of hydride transfer several times earlier, but let us take the glimpse of reduction by $LiAlH_4$ once to understand a few things :



Now, some key points about the mechanism :

(1) The first step here is the fastest step and with the

progress, rate of reaction decreases because $-I$ effect of alkoxy groups oppose the loss of H^- ion. So, obviously the last step is the rate determining step.

(2) Steric hindrance is also a key factor for the subsequent decrease in the rate of the reaction.

(3) For every mole of $LiAlH_4$, 4 moles of ketones are required.

Now, if you go through the mechanism of $NaBH_4$ reduction, then you will find that the basic scheme of the mechanism is exactly same but the twist is while using $NaBH_4$, the first step is found to be the rate determining step.

Well, now we would try to explain this scenario. Suppose the metal hydride is MH_3. It is a Lewis acid which gives $\ddot{M}H_4$. After the reaction with first carbonyl group, it gives $R-\ddot{O}-\overset{H}{\underset{H}{\overset{|}{\underset{|}{M}}}}-H$. Now, two types of effects can be seen here :

Effect 1 :

$$R-\ddot{O}\leftarrow\overset{H}{\underset{H}{\overset{|}{\underset{|}{M}}}}-H$$

It is the electron withdrawing effect of the oxygen atom and this effect lessens the hydride transfer.

Effect 2 :

$$R-\ddot{O}-\overset{H}{\underset{H}{\overset{|}{\underset{|}{M}}}}-H \longrightarrow R-\overset{+}{O}=\overset{H}{\underset{H}{\overset{|}{\underset{|}{M}}}} + H^-$$

It is the mesomeric effect which helps in the release of H^-. Now, in case of $LiAlH_4$ effect 1 operates and in case of $NaBH_4$ effect 2 operates. Reason is simple, due to the smaller size of boron, overlapping takes place effectively and mesomeric effect prevails strongly. But, due to comparatively larger size of Al, effective overlapping does not take place and $-I$ effect strongly prevails here.

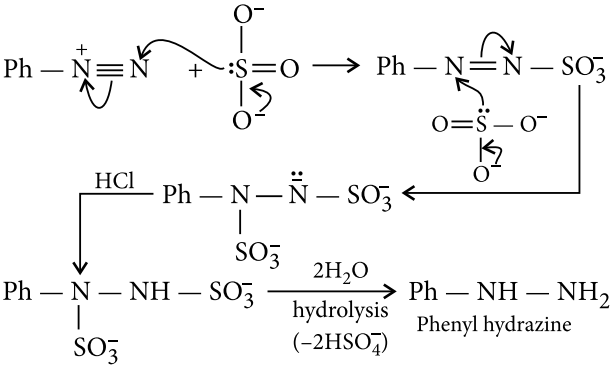
Na_2SO_3 and H_2SO_3

It is a comparatively less used reducing agent. Reduction through electron pair donation get initiated by sulphur atom.

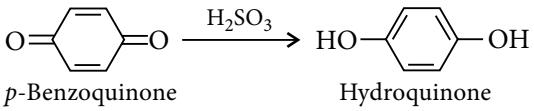
❍ **Reduction of benzene diazonium salt :**

$$Ph-\overset{+}{N}\equiv N \xrightarrow{Na_2SO_3} \text{Adduct} \xrightarrow{\text{conc. HCl}} \xrightarrow{H_2O} Ph-NH-NH_2$$

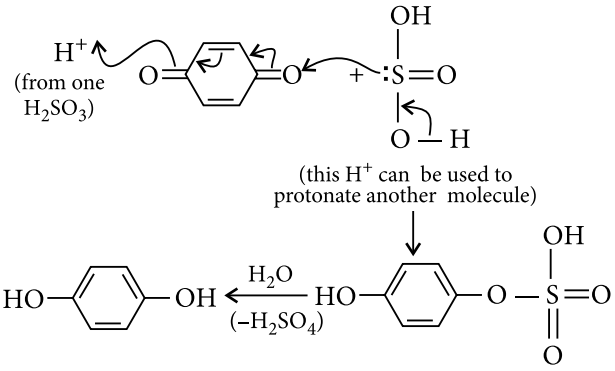
Mechanism :



❍ **Reduction of *p*-benzoquinone :** A famous one :



Mechanism :

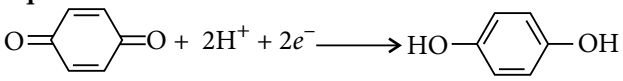


Equation wise this reduction can be shown as below :

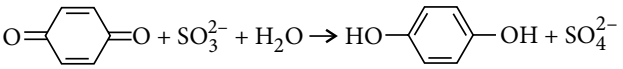
Equation 1 :

$$SO_3^{2-} + H_2O \longrightarrow SO_4^{2-} + 2H^+ + 2e^-$$

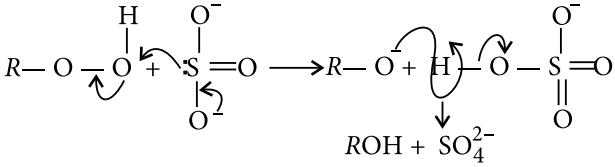
Equation 2 :

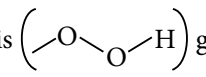


Net equation :



❍ SO_3^{2-} is also capable of reducing peroxide compounds. Mechanism of the reaction can be shown as below :



So, the funda is  group will be converted to —OH group.

CONCEPT MAP

EQUILIBRIUM

Get well-prepared for exams with quick revision of important concepts and formulae of equilibrium.

Class XI Class XII

ALDEHYDES, KETONES AND CARBOXYLIC ACIDS

Get well-prepared for exams with quick revision of some important reactions and tests of Aldehydes, Ketones and Carboxylic acids.

CONCEPT MAP

CHEMICAL EQUILIBRIUM

Law of Chemical Equilibrium

For the reaction, $aA_{(aq)} + bB_{(aq)} \rightleftharpoons xX_{(aq)} + yY_{(aq)}$

$$K_c = \frac{[X]^x[Y]^y}{[A]^a[B]^b}$$

K_c = equilibrium constant in terms of molar concentration

$K_p = K_c(RT)^{\Delta n_g}$

K_p = Equilibrium constant in terms of pressure.

$K_p = K_x(P)^{\Delta n_g}$

K_x = Equilibrium constant in terms of mole fraction.

Relation between different equilibrium constants (K)

Applications of Equilibrium Constant

- Predicting the extent of a reaction :
  - $K_c > 10^3$ [Forward reaction is favoured.]
  - $K_c < 10^{-3}$ [Backward reaction is favoured.]
  - $10^{-3} < K_c < 10^3$ [Both reactants and products are present in equilibrium.]
- Predicting the direction of a reaction :
  - $Q_c < K_c$ [Backward reaction is favoured.]
  - $Q_c > K_c$ [Forward reaction is favoured.]
  - $Q_c = K_c$ [Reaction is in equilibrium.]

Relation between $\Delta G°$ and K

- At equilibrium,
  $\Delta G° = -RT \ln K$; $K = e^{-\Delta G°/RT}$
  - If $\Delta G° < 0$ then $K > 1$
    [Forward reaction is favoured.]
  - If $\Delta G° > 0$ then $K < 1$
    [Backward reaction is favoured.]
  - If $\Delta G° = 0$, $K = 1$
    [Reaction is in equilibrium.]

IONIC EQUILIBRIUM

Ostwald's Dilution Law

Applicable for weak electrolytes

$$\therefore \quad K_c = C\alpha^2 \text{ or } \alpha = \sqrt{\left(\frac{K_c}{C}\right)}$$

So $\alpha \propto \frac{1}{\sqrt{C}}$ or $\alpha \propto \sqrt{V}$ where, V is the volume of solution at infinite dilution.

Ionic Product of Water

$2H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + OH^-_{(aq)}$

$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}\ M^2$

$\therefore \quad [OH^-] = [H^+] = 1.0 \times 10^{-7}$ M at 298 K

$pK_w = pK_a + pK_b = 14$

Hydrolysis of Salts

It is a process in which a salt reacts with water to give acid and base.

- **Salt of Strong Base and Strong Acid :** Neutral solution and does not undergo hydrolysis. *e.g.*, NaCl, KCl.
- **Salt of Weak Base and Strong Acid :**

$$K_h = \frac{K_w}{K_b};\ pH = \frac{1}{2}[pK_w - pK_b - \log C]$$

e.g., NH_4Cl, $CuSO_4$

- **Salt of Strong Base and Weak Acid :**

$$K_h = \frac{K_w}{K_a};\ pH = \frac{1}{2}[pK_w + pK_a + \log C]$$

e.g., CH_3COONa, Na_3PO_4

- **Salt of Weak Acid and Weak Base :**

$$K_h = \frac{K_w}{K_a \times K_b};\ pH = \frac{1}{2}[pK_w + pK_a - pK_b]$$

e.g., CH_3COONH_4, $AlPO_4$

pH Concept

$pH = -\log[H^+]$ or $pH = -\log[H_3O^+]$ or $[H^+] = 10^{-pH}$

For weak acid; $pH = \frac{1}{2}(pK_a - \log C)$

For weak base; $pOH = \frac{1}{2}(pK_b - \log C)$, $pH = 14 - pOH$

For mixture of two weak acids; $[H^+] = \sqrt{K_{a_1}C_1 + K_{a_2}C_2}$

For mixture of two weak bases; $[OH^-] = \sqrt{K_{b_1}C_1 + K_{b_2}C_2}$

Aldehydes

General formula : $C_nH_{2n}O$

IUPAC name : Alkanal

Ketones

General formula : $C_nH_{2n}O$

IUPAC name : Alkanone

Carboxylic Acids

General formula : $C_nH_{2n}O_2$

IUPAC name : Alkanoic acid

Chemical Properties

Nucleophilic addition-elimination reactions

$>C=O$ —(i) NH_3, (ii) Δ→ $>C=NH + H_2O$ (Imine)

$>C=O$ —(i) NH_2-Z, (ii) Δ→ $>C=N-Z + H_2O$

Z = Alkyl, Aryl, —OH, —NH_2, —NHC_6H_5, —NH(2,4-dinitrophenyl), —$NH-C(=O)-NH_2$

- $RCHO \xrightarrow{\text{Reduction}} RCH_2OH$
- $RCOR' \xrightarrow{\text{Reduction}} RCH(OH)R'$

(H_2/Ni or Pt or Pd, $LiAlH_4$ or $NaBH_4$)

- $RCHO \xrightarrow{\text{Reduction}} RCH_3$
- $RCOR' \xrightarrow{\text{Reduction}} RCH_2R'$

(Zn-Hg/HCl, NH_2NH_2/KOH, HI/Red P)

- $RCHO \xrightarrow{\text{Oxidation}} RCOOH$ (Even with mild oxidizing agents, same no. of C-atoms)
- $RCOR' \xrightarrow{\text{Oxidation}} RCOOH$ (With strong oxidizing agents, lesser no. of C-atoms)

Haloform reaction

Given by compounds having CH_3CO— group or $CH_3CH(OH)$— group.

$RCOCH_3 \xrightarrow{NaOX} RCOONa + CHX_3$ (Haloform)

Aldol condensation

- Aldehydes and ketones having at least one α-H atom undergo a reaction in the presence of dilute alkali as a catalyst to form β-hydroxyaldehydes (aldol) or β-hydroxyketones (ketol), respectively.
- The aldol and ketol readily lose water to give α, β-unsaturated carbonyl compounds.

$2CH_3CHO \xrightarrow{\text{dil. NaOH}} CH_3-CH(OH)-CH_2-CHO$ (aldol) $\xrightarrow{\Delta} CH_3-CH=CH-CHO$

Cannizzaro reaction

Aldehydes which do not have α-H atom undergo disproportionation on heating with concentrated alkali.

$2HCHO + NaOH \xrightarrow{\Delta} CH_3OH + HCOONa$

Chemical Properties

- $RCOOH \xrightarrow{R'COOH/H^+,\ \Delta} (RCO)_2O$ (Acid anhydride)
- $RCOOH \xrightarrow[\text{or } SOCl_2 \text{ in pyridine}]{PCl_3 \text{ or } PCl_5} RCOCl$ (Acid chloride)
- $RCOOH \xrightarrow{Na} RCOONa + H_2$
- $RCOOH \xrightarrow{Na_2CO_3/NaHCO_3} RCOONa + CO_2 + H_2O$
- $RCOOH \xrightarrow{LiAlH_4/\text{ether or } B_2H_6/\text{ether}} RCH_2OH$
- $RCH_2COOH \xrightarrow[(ii)\ H_2O]{(i)\ X_2/\text{Red P}} R-CH(X)-COOH$ (α-Halocarboxylic acid)

(Hell-Volhard Zelinsky reaction)

Test for Carboxylic Group

Test	Inference
$NaHCO_3$	Brisk effervescence of CO_2 gas
$FeCl_3$	Buff coloured ppt.

Distinction Test

Test	Aldehydes	Ketones
Schiff's reagent	Pink colour	No colour
Fehling's solution	Red ppt.	No ppt.
Tollens' reagent	Silver mirror	No ppt.
Sodium hydroxide	Brown resinous mass (formaldehyde does not give this test).	No reaction
Alkaline sodium nitroprusside	A deep red colour (formaldehyde does not respond to this test).	Red colour which changes to orange.

CHEMISTRY MUSING

SOLUTION SET 57

1. (b): $q = m \times c_s \times \Delta T$ (for combustion of benzoic acid)

$$\frac{0.316 \times 3227}{122} = mc_s \times 3.24$$

$$mc_s = \frac{0.316 \times 3227}{122 \times 3.24} = 2.58 \text{ kJ/°C}$$

For banana slice; $q = mc_s\Delta T$

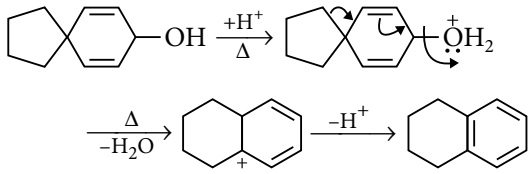
$$q = 2.58 \times 3.05$$

$$= 7.87 \text{ kJ per } 2.502 \text{ g banana}$$

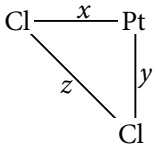
$$\therefore \text{ Heat produced by } 125 \text{ g banana} = \frac{7.87 \times 125}{2.502}$$

$$= 393.18 \text{ kJ} = \frac{393.18}{4.184} \text{ kcal} = 93.97 \text{ kcal}$$

2. (a):



3. (d): In compound (*B*)



$$\therefore \quad z^2 = x^2 + y^2 = 2x^2$$

$$z = x\sqrt{2} = 2.32 \times 1.414 = 3.28 \text{ Å}$$

4. (a):

$$2P_4 + 3Ba(OH)_2 + 6H_2O \xrightarrow{\Delta} 2PH_3 + 3Ba(H_2PO_2)_2$$

Salt (*X*)

$\downarrow H_2SO_4$

$$H_3PO_4 + PH_3 \xleftarrow{\Delta} 2H_3PO_2 + BaSO_4$$

(*A*) Oxoacid(*Y*)

H_3PO_4 (*A*) $\xrightarrow{\Delta,\ 250\,°C}$ $H_4P_2O_7$ $\xrightarrow{600\,°C/\Delta}$ HPO_3

H_3PO_4 (*A*) $\xrightarrow{\Delta,\ 600\,°C}$ HPO_3

5. (d): The third reaction generates an aromatic ion, thus it is most stable. The first reaction generates a simple ion, while the second reaction gives an antiaromatic ion, which is less stable. Thus, the reaction leading to the formation of most stable ion is the fastest.

6. (a): $\Delta T_f = K_f \times i \times m$

$$= K_f \times (1 + \alpha) \times \frac{w_2}{m_1} \times \frac{1000}{w_1(\text{in g})}$$

$$\therefore \quad 0.406 = 1.86 \times (1 + \alpha) \times \frac{0.7}{58.5} \times \frac{1000}{99.3}$$

$$\therefore \quad 1 + \alpha = \frac{0.406 \times 58.5 \times 99.3}{1.86 \times 0.7 \times 1000}$$

Assuming dilute solution,

100 g H_2O = 100 mL H_2O = 0.1 L solutions

$$\pi = i \times \frac{n_2}{V} \times RT = (1+\alpha) \times \frac{w_2}{m_2} \times \frac{1}{V} \times RT$$

$$= \frac{0.406 \times 58.5 \times 99.3}{1000 \times 1.86 \times 0.7} \times \frac{0.7}{58.5} \times \frac{1}{0.1} \times 0.082 \times 298$$

= 5.29 atm

7. (a): Total mmoles of $BrO_3^- = 20 \times \frac{1}{60} = \frac{1}{3}$

Total mmoles of $AsO_2^- = \frac{1}{60} \times 5 = \frac{1}{12}$

According to the balanced equations,

$$\underset{5 \text{ mmol}}{5SeO_3^{2-}} + \underset{2 \text{ mmol}}{2BrO_3^-} + 2H^+ \longrightarrow 5SeO_4^{2-} + Br_2 + H_2O \quad ...(i)$$

$$\underset{1 \text{ mmol}}{BrO_3^-} + \underset{3 \text{ mmol}}{3AsO_2^-} + 3H_2O \longrightarrow Br^- + 3AsO_4^{3-} + 6H^+ \quad ...(ii)$$

$\because$ 3 mmol of AsO_2^- = 1 mmol of BrO_3^- in eq. (ii)

$$\therefore \quad \frac{1}{12} \text{ mmol of } AsO_2^- = \frac{1}{3} \times \frac{1}{12} = \frac{1}{36} \text{ mmol of excess } BrO_3^-$$

mmoles of BrO_3^- reacted with SeO_3^{2-} in eq. (i)

$$= \frac{1}{3} - \frac{1}{36} = \frac{11}{36}$$

Now, in equation (ii),

meq of BrO_3^- = meq of AsO_2^-

$$\frac{1}{36} \times 6 \text{ meq} = \frac{1}{12} \times 2 \text{ meq}$$

Excess meq of $BrO_3^- \equiv \frac{1}{6}$ meq

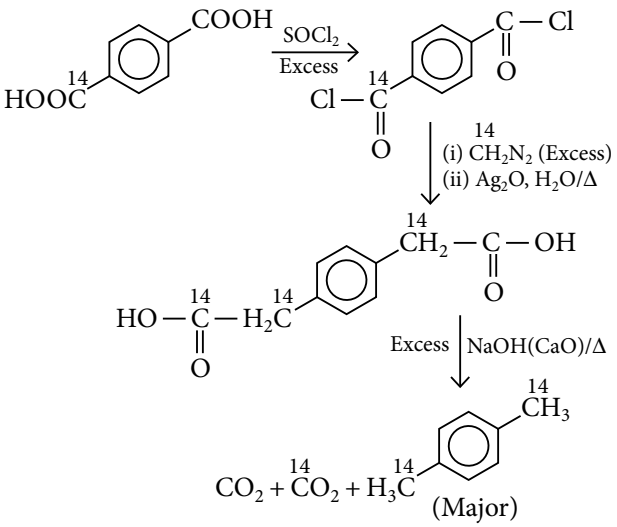
8. (d): meq of $SeO_3^{2-} = \frac{55}{36}$

Weight of SeO_3^{2-} = meq $\times 10^{-3} \times$ eq.wt.

$$\left(\text{eq.wt. of } SeO_3^{2-} = \frac{127}{2}\right)$$

$$= \frac{55}{36} \times 10^{-3} \times \frac{127}{2} \text{ g} = 0.097 \text{ g} = 97 \text{ mg}$$

9. (2):



10. (1): meq of unreacted Na_2CO_3 = meq of H_2SO_4

$$= \frac{1\times10}{50} = \frac{1}{5}$$

Total meq of Na_2CO_3 taken $= \frac{1\times20}{50} = \frac{2}{5}$

meq of Na_2CO_3 absorbed by $H_2O = \frac{2}{5} - \frac{1}{5} = \frac{1}{5}$

Weight of Na_2CO_3 absorbed by H_2O

$= \frac{1}{5}\times10^{-3}\times53\,g$ ($\because$ eq. wt. of $Na_2CO_3 = 53$)

= 0.0106 g Na_2CO_3 in 100 mL of H_2O

106 g of $Na_2CO_3 \equiv$ 100 g of $CaCO_3$

So, 0.0106 g of $Na_2CO_3 \equiv \frac{0.0106}{106}\times100$

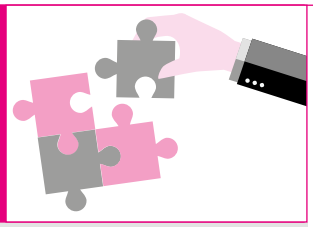
$= 0.01$ g of $CaCO_3$

$= \frac{0.01\times1000}{100}$ g of $CaCO_3$ in 1 L of H_2O

= 0.1 g of $CaCO_3$ in 1 L of H_2O

= 1×10^{-1} g of $CaCO_3$ 1 L of H_2O comparing it with $x \times 10^{-1}$, we get $x = 1$.

PUZZLE CORNER



CHEMDOKU

In this puzzle 5 × 5 grid is given, your objective is to fill the digits 1-5 so that each appear exactly once in each row and each column.

Notice that most boxes are part of a cluster. In the upper-left corner of each multibox cluster is a value that is addition, substraction or multiple (as indicated) of its numbers. For example, if that value is 3× for a two-box cluster, you know that only 1 and 3 can go in there. But it is your job to determine which number goes where! A few cluster may have just one box and that is the number that fills that box.

Note : Atomic number of the given elements to be considered as your answer.

Clues :

(a) Some of its alloys are magnalium and elektron metal. Its ribbon along with barium peroxide is used as ignition mixture in aluminothermite process.

(b) It was isolated by Moissan in 1886 after a hard labour of many chemist for about 75 years. The reason for its late discovery were its high reactivity and non-conducting nature of its hydroacid.

a×	b+			c×
		d×		
e×			f×	
g×		h−		
			i×	

(c) This metal produces a peculiar sound whenever it is bent. Its chloride is used for making purple of Cassius which is used for colouring glass and pottery.

(d) When its fibres are incorporated in plastics, the result is very tough material that is stiffer than steel yet lighter than aluminium and used in aircraft, missiles and body armour.

(e) The largest use of this metal is in steel making due to its strong affinity for oxygen and sulphur. It is also used as a reducing agent in preparing other metals such as thorium and uranium.

(f) It is mostly used as an inert shielding gas in welding and other high temperature industrial process, it is also used in the poultry industry to asphyxiate birds.

(g) Traces of this metal in the form of organo-metallic compounds, have been reported in the animal cells and in snake-poison. When this metal is heated in air strongly it burns, forming white smoke which settles down to soft woolly flocks of its oxide called philosopher's wool or pompholyx.

(h) A mixture of 80% of an element and 20% oxygen is used instead of ordinary air, by divers for respiration. The same mixture is used to assist breathing in asthma and other respiratory diseases, as the element is not soluble in blood even under high pressure.

(i) Emerald is a crystal of a mineral with some Cr^{3+} ions which are responsible for the colour of emerald. One of this mineral's constituent is used as windows of X-ray tubes.

Readers can send their responses at editor@mtg.in or post us with complete address by 25th of every month to win exciting prizes. Winners' name with their valuable feedback will be published in next issue.

FULL LENGTH PRACTICE PAPER

BITSAT

Exam date : 16th to 31st May 2018

SECTION-I (PHYSICS)

1. Two stones having different masses m_1 and m_2 are projected at angles θ and (90° – θ) with same velocity from the same point. The ratio of their maximum heights is

(a) 1 : 1 (b) 1 : tan θ

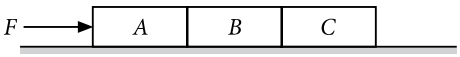
(c) tan θ : 1 (d) $\tan^2\theta$: 1

2. A mass M is suspended from a light spring. An additional mass m is added, displaces the spring further by a distance x. Now, the combined mass will oscillate with a period

(a) $T = 2\pi\sqrt{\frac{mg}{x(M+m)}}$ (b) $T = 2\pi\sqrt{\frac{(M+m)x}{mg}}$

(c) $T = 2\pi\sqrt{\frac{mgx}{(M+m)}}$ (d) $T = 2\pi\sqrt{\frac{(M+m)}{mgx}}$

3. Three identical blocks, each having a mass m are pushed by a force F on a frictionless table as shown in figure.



(i) What is the acceleration of the blocks? (ii) What is the net force on the block A? (iii) What force does A apply on B? (iv) What force does B apply on C?

	(i)	(ii)	(iii)	(iv)
(a)	$F/3m$	$F/3$	$2F/3$	$F/3$
(b)	$F/4m$	$F/3$	$2F/3$	$F/3$
(c)	$F/3m$	$F/4$	$2F/3$	$F/3$
(d)	$F/3m$	$F/3$	$2F/4$	$F/3$

4. When a light of photons of energy 4.2 eV is incident on a metallic sphere of radius 10 cm and work function 2.4 eV, photoelectrons are emitted. The number of photoelectrons liberated before the emission is stopped, is

($e = 1.6 \times 10^{-19}$ C and $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2})

(a) 6.25×10^8 (b) 1.25×10^{18}

(c) 1.25×10^8 (d) 6.25×10^{18}

5. A radioactive substance has density ρ, volume V and decay constant λ. If the molecular weight of the substance is M, and Avogadro number is N_A, then the activity of the substance after time t is

(a) $\left(\frac{\lambda V \rho N_A}{M}\right)(1-e^{-\lambda t})$ (b) $\left(\frac{N_A V}{\rho M}\right)e^{-\lambda t/2}$

(c) $\left(\frac{\lambda N_A}{V\rho M}\right)e^{-\lambda t}$ (d) $\left(\frac{\lambda V \rho N_A}{M}\right)e^{-\lambda t}$

6. If the position vector of a particle is given by :

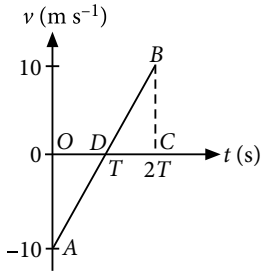
$\vec{r} = (4\cos 2t)\hat{i} + (4\sin 2t)\hat{j} + (6t)\hat{k}$ m,

its acceleration at $t = \pi/4$ s in m s^{-2} is

(a) $16\hat{i}$ (b) $-16\hat{k}$

(c) $-16\hat{j}$ (d) $16(\hat{i}+\hat{j})$

7. The figure shows the velocity (v) of a particle plotted against time (t).



Mark the incorrect statement.

(a) The displacement of the particle in time $2T$ is zero.

(b) The initial and final speeds of the particle are the same.

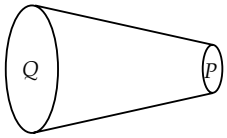
(c) The acceleration of the particle remains constant throughout the motion.

(d) The particle does not change its direction of motion.

8. A paramagnetic sample shows a net magnetisation of 0.8 A m^{-1}, when placed in an external magnetic field of strength 0.8 T at a temperature 5 K. When the same sample is placed in an external magnetic field of 0.4 T at a temperature of 20 K, the magnetisation is

(a) 0.1 A m^{-1} (b) 0.2 A m^{-1}
(c) 0.4 A m^{-1} (d) 0.8 A m^{-1}

9. A conductor has a non-uniform section as shown in the figure. A steady current is flowing through it. Then the drift speed of the electrons



(a) varies unpredictably
(b) increases from *P* to *Q*
(c) decreases from *P* to *Q*
(d) is constant throughout the conductor.

10. The dimensions of a rectangular block measured with callipers having least count of 0.01 cm are 5 mm × 10 mm × 5 mm. The maximum percentage error in the measurement of the volume of the block is

(a) 5% (b) 10% (c) 15% (d) 20%

11. If in an amplitude modulated wave, the maximum amplitude is 10 V and the modulation index is 2/3, then the minimum amplitude is

(a) 2 V (b) 7 V (c) 9 V (d) 6 V

12. Two polarisers have their axes inclined at 45° to each other. If unpolarised light of intensity I_0 is incident on the first polariser, then the intensity of light transmitted through second polariser is

(a) $\frac{I_0}{4}$ (b) $\frac{I_0}{2}$ (c) I_0 (d) 0

13. A plane electromagnetic wave travels in free space. Then the ratio of the magnitudes of electric and magnetic fields at a point is equal to

(a) energy of electromagnetic wave.
(b) inverse of the velocity of the electromagnetic wave.
(c) inverse of the energy of electromagnetic wave.
(d) velocity of electromagnetic wave.

14. A car starts from station and moves along the horizontal road by a machine delivering constant power. The distance covered by the car in time *t* is proportional to

(a) t^2 (b) $t^{3/2}$ (c) $t^{2/3}$ (d) t^3

15. A 0.01 H inductor and $\sqrt{3}\pi\,\Omega$ resistance are connected in series with a 220 V, 50 Hz ac source. The phase difference between the current and the voltage is

(a) $\frac{\pi}{2}$ (b) $\frac{\pi}{6}$ (c) $\frac{\pi}{3}$ (d) $\frac{\pi}{4}$

16. A block of mass 2 kg initially at rest is dropped from a height of 1 m into a vertical spring having force constant 490 N m^{-1}. The maximum distance through which the spring will be compressed, is

(a) 0.11 m (b) 0.33 m
(c) 0.22 m (d) 0.44 m

17. A flash light lamp is marked 3.5 V and 0.28 A. The filament temperature is 425°C. The filament resistance at 0°C is 4 Ω. Then, the temperature coefficient of resistance of the material of the filament is

(a) 8.5×10^{-3} °C^{-1} (b) 3.5×10^{-3} °C^{-1}
(c) 0.5×10^{-3} °C^{-1} (d) 5×10^{-3} °C^{-1}

18. An infinitely long thin straight wire has uniform linear charge density of $\frac{1}{3}$C m^{-1}. Then, the magnitude of the electric intensity at a point 18 cm away is

(a) 0.33×10^{11} N C^{-1} (b) 3×10^{11} N C^{-1}
(c) 0.66×10^{11} N C^{-1} (d) 1.32×10^{11} N C^{-1}

19. A Carnot engine operates with a source at 500 K and sink at 375 K. Engine consumes 600 kcal of heat per cycle. The heat rejected to sink per cycle is

(a) 250 kcal (b) 350 kcal
(c) 450 kcal (d) 550 kcal

20. A satellite is placed in a circular orbit around earth at such a height that it always remains stationary with respect to earth surface. In such case, its height from the earth surface is

(a) 32000 km (b) 36000 km
(c) 3400 km (d) 4800 km

21. An electrical device which offers a low resistance to the current in one direction but a high resistance to the current in opposite direction is

(a) current amplifier (b) oscillator
(c) power amplifier (d) rectifier

22. A glass slab of thickness 8 cm contains the same number of waves as 10 cm long path of water when both are traversed by the same monochromatic light. If the refractive index of water is $\frac{4}{3}$, the refractive index of glass is

(a) $\frac{5}{3}$ (b) $\frac{5}{4}$ (c) $\frac{16}{15}$ (d) $\frac{3}{2}$

23. Two pendulums of length 1 m and 16 m start vibrating one behind the other from the same stand. At some instant, the two are in the mean position in the same phase. The time period of shorter pendulum is T. The minimum time after which the two threads of the pendulum will be one behind the other is

(a) $T/4$ (b) $T/3$ (c) $4T/3$ (d) $4T$

24. A p-n-p transistor is used in common emitter mode in an amplifier circuit. When base current is changed by an amount ΔI_B, the collector current changes by 2 mA. If the current amplification factor is 50, then the value of ΔI_B is

(a) 15 μA (b) 40 μA (c) 50 μA (d) 60 μA

25. A shell is fired from a cannon with a velocity v at an angle θ with the horizontal. At the highest point in its path it explodes into two pieces of equal masses. One of the pieces retraces its path and reaches the cannon. Then the velocity of the other piece immediately after the explosion is

(a) $2v\cos\theta$ (b) $\frac{3}{2}v\cos\theta$

(c) $3v\cos\theta$ (d) $2v\sin\theta$

26. A denotes the cross-sectional area of a cubical tank, h the depth of an orifice of area of cross-section a, below the liquid surface. The velocity of the liquid flowing through the orifice is

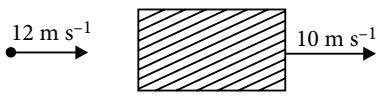
(a) $\sqrt{2gh}$ (b) $\sqrt{2gh}\sqrt{\left(\frac{A^2}{A^2-a^2}\right)}$

(c) $\sqrt{2gh}\sqrt{\left(\frac{A}{A-a}\right)}$ (d) $\sqrt{2gh}\sqrt{\left(\frac{A^2-a^2}{A^2}\right)}$

27. If the wavelength of light that is emitted from hydrogen atom when an electron falls from orbit n = 2 to orbit n = 1 is 122 nm, then minimum wavelength of the series is

(a) 405 Å (b) 9150 Å (c) 812 Å (d) 915 Å

28. A light particle moving horizontally with a speed of 12 m s^{-1} strikes a very heavy block moving in the same direction at 10 m s^{-1}. The collision is one dimensional and elastic. After the collision, the particle will

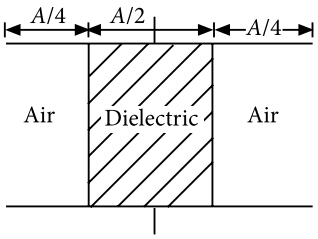


(a) move at 2 m s^{-1} in its original direction
(b) move at 8 m s^{-1} in its original direction
(c) move at 8 m s^{-1} opposite to its original direction
(d) move at 12 m s^{-1} opposite to its original direction.

29. A bat flies at a steady speed of 4 m s^{-1} emitting 90 kHz sound waves and is flying towards a wall. It detects a reflected signal at a frequency (Take speed of sound = 340 m s^{-1})

(a) 90.1 kHz (b) 91.1 kHz
(c) 92.1 kHz (d) 93.1 kHz

30. Consider a parallel plate capacitor of capacitance 10 μF filled with air. When the gap between the plates is filled partly with a dielectric of dielectric constant 4,



as shown in figure, the new capacitance of the capacitor is (A is the area of each plate)

(a) 20 μF (b) 40 μF (c) 2.5 μF (d) 25 μF

31. Choose the correct statement.

(a) Polar molecules have permanent electric dipole moment.
(b) CO_2 molecule is a polar molecule.
(c) H_2O is a non-polar molecule.
(d) The dipole field at large distances falls off as $\frac{1}{r^2}$.

32. Two deuterium nuclei each of mass m, fuse together to form a helium nucleus, releasing an energy E. If c is the velocity of light, the mass of helium nucleus formed will be

(a) $2m+\frac{E}{c^2}$ (b) $\frac{E}{mc^2}$

(c) $m+\frac{E}{c^2}$ (d) $2m-\frac{E}{c^2}$

33. A block of mass 10 kg is moving horizontally with a speed of 1.5 m s^{-1} on a smooth plane. If a constant vertical force 10 N acts on it, the displacement of the block from the point of application of the force at the end of 4 s is

(a) 5 m (b) 20 m (c) 12 m (d) 10 m

34. An aeroplane is flying horizontally with a velocity of 216 km h^{-1} and at a height of 1960 m. When it is vertically above a point A on the ground, a bomb is released from it. The bomb strikes the ground at point B. The distance AB is (ignoring air resistance)

(a) 1.2 km (b) 0.33 km
(c) 3.33 km (d) 33 km

35. The objective lens of an optical instrument is an achromatic combination with a focal length of 90 cm. The two lenses possess dispersive powers 0.024 and 0.036 respectively and are in contact with each other. Then their focal lengths are

(a) –30 cm, 45 cm (b) 45 cm, 30 cm
(c) 30 cm, –45 cm (d) 30 cm, –30 cm

36. Water is boiled in flat bottom kettle placed on a stove. The area of the bottom is 3000 cm^2 and the thickness is 2 mm. If the amount of steam produced is 1 g min^{-1}, the difference of temperature between the inner and outer surfaces of the bottom is (Given : Thermal conductivity of the material of kettle is 0.5 cal $°C^{-1}s^{-1}cm^{-1}$)

(a) 2.1×10^{-3} °C (b) 3.1×10^{-3} °C
(c) 1.2×10^{-3} °C (d) 2.5×10^{-3} °C

37. A charged particle with velocity $\vec{v} = x\hat{i} + y\hat{j}$ moves in a magnetic field $\vec{B} = y\hat{i} + x\hat{j}$. The magnitude of the force acting on the particle is F. The correct option for F is

(i) No force will act on the particle if $x = y$.
(ii) Force will act along y axis if $y < x$.
(iii) Force is proportional to $(x^2 - y^2)$ if $x > y$.
(iv) Force is proportional to $(x^2 + y^2)$ if $y > x$.

(a) (i) and (ii) are true (b) (i) and (iii) are true
(c) (ii) and (iv) are true (d) (iii) and (iv) are true.

38. A body of mass m is raised to a height h from the surface of the earth where the acceleration due to gravity is g. If R is the radius of the earth and $h << R$, then the loss in weight due to variation in g is approximately

(a) $\frac{2mgh}{R}$ (b) $\frac{2mgR}{h}$
(c) $\frac{mgR}{h}$ (d) $\frac{mgh}{R}$

39. An astronomical telescope arranged for normal adjustment has a magnification of 6. If the length of the telescope is 35 cm, then the focal lengths of objective and eyepiece respectively are

(a) 30 cm, 6 cm (b) 30 cm, 5 cm
(c) 5 cm, 30 cm (d) 40 cm, 5 cm

40. Displacement of a body is $(5\hat{i} + 3\hat{j} - 4\hat{k})$ m when a force $(6\hat{i} + 6\hat{j} + 4\hat{k})$ N acts for 5 s. The power is

(a) 1.6 W (b) 9.6 W
(c) 6.4 W (d) 3.2 W

SECTION-II (CHEMISTRY)

41. Name the structure of silicate in which two oxygen atoms of $[SiO_4]^{4-}$ are shared.

(a) Pyrosilicate
(b) Sheet silicate
(c) Linear chain silicate
(d) Three dimensional silicate

42. If Fe^{2+}, Fe^{3+} and Fe blocks are kept together, then [Given : $Fe^{2+} | Fe$ ($E° = -0.44$ V), $Fe^{3+} | Fe^{2+}$ ($E° = 0.77$ V)]

(a) Fe^{3+} increases
(b) Fe^{3+} decreases
(c) Fe^{2+}/Fe^{3+} remains unchanged
(d) Fe^{2+} decreases.

43. 0.2 g of an organic compound on complete combustion produces 0.18 g of water, then the percentage of hydrogen in it, is

(a) 5 (b) 10
(c) 15 (d) 20

44. Why HCl is not used to make the medium acidic in oxidation reactions of $KMnO_4$?

(a) Both HCl and $KMnO_4$ act as oxidising agents.
(b) $KMnO_4$ oxidises HCl into Cl_2, which also acts as an oxidising agent.
(c) $KMnO_4$ is a weaker oxidising agent than HCl.
(d) $KMnO_4$ acts as a reducing agent in the presence of HCl.

45. Given the equilibrium constant values,

I. $N_{2(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons N_2O_{(g)}$; $K_c = 2.7 \times 10^{-18}$

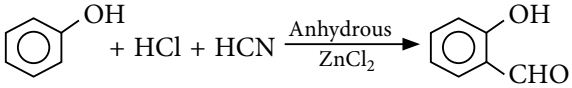
II. $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$; $K_c = 4.6 \times 10^{-3}$

III. $\frac{1}{2}N_{2(g)} + O_{2(g)} \rightleftharpoons NO_{2(g)}$; $K_c = 4.1 \times 10^{-9}$

Thus, for the reaction,
$2N_2O_{(g)} + 3O_{2(g)} \rightleftharpoons 2N_2O_{4(g)}$, K_c is

(a) 5.46×10^{7} (b) 5.46×10^{-7}
(c) 1.832×10^{-6} (d) 1.832×10^{6}

46. The following reaction,



is known as

(a) Perkin reaction
(b) Gattermann reaction
(c) Kolbe reaction
(d) Gattermann-Koch reaction.

47. Which one of the following statements is correct?
(a) The elements having large negative values of electron gain enthalpy generally act as strong oxidising agents.
(b) The elements having low values of ionisation enthalpies act as strong reducing agents.
(c) The formation of $S^{2-}_{(g)}$ from $S_{(g)}$ is an endothermic process.
(d) All of these.

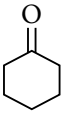
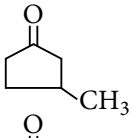
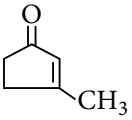
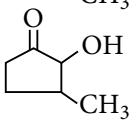
48. Consider the Arrhenius equation given below and mark the correct option :
$k = Ae^{-E_a/RT}$
(a) Rate constant increases exponentially with increasing activation energy and decreasing temperature.
(b) Rate constant decreases exponentially with increasing activation energy and decreasing temperature.
(c) Rate constant increases exponentially with decreasing activation energy and decreasing temperature.
(d) Rate constant increases exponentially with decreasing activation energy and increasing temperature.

49. The reaction conditions leading to the best yields of C_2H_5Cl are
(a) C_2H_6 (Excess) + $Cl_2 \xrightarrow{\text{UV light}}$
(b) $C_2H_6 + Cl_2 \xrightarrow{\text{dark room temp.}}$
(c) $C_2H_6 + Cl_2$ (Excess) $\xrightarrow{\text{UV light}}$
(d) $C_2H_6 + Cl_2 \xrightarrow{\text{UV light}}$

50. When a metal rod *P* is dipped into an aqueous colourless concentrated solution of compound *Q* the solution turns light blue. Addition of aqueous NaCl to the blue solution gives a white precipitate *R*. Addition of aqueous NH_3 dissolves *R* and gives an intense blue solution. The metal rod *P* is
(a) Fe (b) Cu (c) Ni (d) Co

51. The energy required to break one mole of Cl—Cl bonds in Cl_2 is 242 kJ mol^{-1}. The longest wavelength of light capable of breaking a single Cl—Cl bond is :
($c = 3 \times 10^8$ m s^{-1} and $N_A = 6.02 \times 10^{23}$ mol^{-1})
(a) 494 nm (b) 594 nm
(c) 640 nm (d) 700 nm

52. The diketone $CH_3-\overset{O}{\overset{\|}{C}}-(CH_2)_2-\overset{O}{\overset{\|}{C}}-CH_3$ on intramolecular aldol condensation gives the final product

(a) 
(b) 
(c) 
(d) 

53. Three samples of H_2O_2 labelled as 10 vol, 15 vol, 20 vol. Half litre of each sample is mixed and then diluted with equal volume of water. Calculate volume strength of the resultant solution.
(a) 1.339 (b) 7.5 (c) 5.0 (d) 2.68

54. Which of the following point defects are shown by $AgBr_{(s)}$ crystals?
(A) Schottky defect (B) Frenkel defect
(C) Metal excess defect (D) Metal deficiency defect
(a) (A) and (B) (b) (C) and (D)
(c) (A) and (C) (d) (B) and (D)

55. Aerosol of a jet air liner which destroys the ozone layer of atmosphere is
(a) CF_2Cl_2 (b) CO_2 and SO_2
(c) SO_2 (d) NH_3 and CCl_4

56. The product of reaction between aniline and acetic anhydride is
(a) *o*-aminoacetophenone
(b) *m*-aminoacetophenone
(c) *p*-aminoacetophenone
(d) acetanilide.

57. For a gas, $\left(\frac{dE}{dV}\right)_T = 0$, then
(a) $\left(\frac{dH}{dP}\right)_T = P\left(\frac{dV}{dP}\right)_T + V$
(b) if the gas is ideal then $\left(\frac{dH}{dP}\right)_T = 0$
(c) $\left(\frac{dC_v}{dV}\right)_T = 0$
(d) all of these.

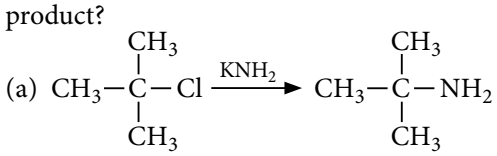
58. Which of the following solutions will turn violet when a drop of lime juice is added to it?
(a) A solution of NaI.
(b) A solution mixture of KI and $NaIO_3$.
(c) A solution mixture of NaI and KI.
(d) A solution mixture of KIO_3 and $NaIO_3$.

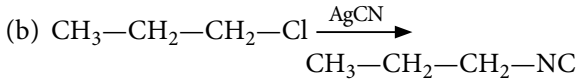
59. A gas on passing through ammonical solution of $AgNO_3$ does not give any precipitate but decolourises alkaline $KMnO_4$ solution. The gas may be
(a) C_2H_2 (b) C_2H_4 (c) C_3H_4 (d) C_3H_3

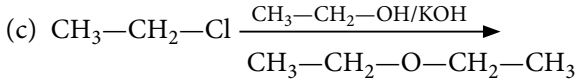
60. How much amount of KCl must be added to 1 kg of water so that the freezing point is depressed by 2 K? (K_f for water = 1.86 K kg mol^{-1})
(a) 40 g (b) 20 g (c) 10 g (d) 60 g

61. Which of the following is most easily hydrolysed amongst the following?
(a) SF_6 (b) NF_3 (c) CCl_4 (d) TeF_6

62. Which of the following is not showing the main product?

(a) 

(b) 

(c) 

(d) $CH_3Cl + CH_3COOAg \longrightarrow CH_3COOCH_3$

63. For the given reaction,
$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 6Cl^{-}_{(aq)} + 3H_{2(g)}$
Which of the following statements is correct?
(a) 11.2 L $H_{2(g)}$ at STP is produced for every mole of $HCl_{(aq)}$ consumed.
(b) 6 L $HCl_{(aq)}$ is consumed for every 3 L of $H_{2(g)}$ produced.
(c) 3.36 L $H_{2(g)}$ is produced for every mole of Al that reacts.
(d) 67.2 L $H_{2(g)}$ at STP is produced for every mole of Al that reacts.

64. Electrolytic reduction method is used in extraction of
(a) highly electronegative elements
(b) metalloids
(c) transition metals
(d) highly electropositive elements.

65. The possible set of quantum no. for the unpaired electron of chlorine is

	n	l	m		n	l	m
(a)	2	1	0	(b)	2	1	1
(c)	3	1	1	(d)	3	0	0

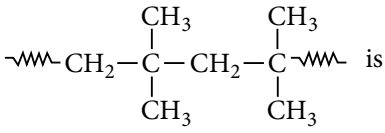
66. A diabetic person carries a packet of glucose with him always, because
(a) glucose increases the blood sugar level slowly
(b) glucose reduces the blood sugar level fastly
(c) glucose increases the blood sugar level almost instantaneously
(d) glucose reduces the blood sugar level slowly.

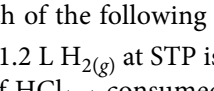
67. Root mean square velocity of a gas is x m s^{-1} at a pressure p atm and temperature T K. If pressure is made $2p$ under isothermal condition, root mean square speed becomes
(a) $2x$ (b) $4x$ (c) $\frac{x}{2}$ (d) x

68. Select the incorrect statement.
(a) SO_2 gas has oxidising as well as reducing behaviour.
(b) O_3 causes tailing of Hg.
(c) $KI_{(s)}$ reacts with conc. H_2SO_4 to produce HI.
(d) O_3 oxidises KI to I_2 in acidic medium.

69. 20 mL of methane is completely burnt using 50 mL of oxygen. The volume of the gas left after cooling to room temperature is
(a) 80 mL (b) 40 mL (c) 60 mL (d) 30 mL

70. The monomer of the given polymer

 is

(a)  (b) $(CH_3)_2C = C(CH_3)_2$
(c) $CH_3CH = CHCH_3$ (d) $CH_3CH = CH_2$

71. The *rms* velocity of molecules of a gas of density 4 kg m^{-3} and pressure 1.2×10^5 N m^{-2} is
(a) 900 m s^{-1} (b) 120 m s^{-1}
(c) 600 m s^{-1} (d) 300 m s^{-1}

72. Amount of gas adsorbed per gram of adsorbent increases with pressure, but after certain limit is reached, adsorption becomes constant, this is because
(a) multilayers are formed
(b) desorption takes place
(c) temperature is increased
(d) absorption also started.

73. How many structural isomers are possible in diphenyl methane when one atom of hydrogen is replaced by a chlorine atom?
(a) 8 (b) 7 (c) 6 (d) 4

74. The density of solid argon is 1.65 g per cc at –233 °C. If the argon atom is assumed to be a sphere of radius 1.54×10^{-8} cm, then what percentage of solid argon is apparently empty space? (Ar = 40)
(a) 16.5% (b) 38%
(c) 50% (d) 62%

75. $Cr_2O_7^{2-} + X \xrightarrow{H^+} Cr^{3+} + H_2O$ + oxidation product of X.

X cannot be

(a) $C_2O_4^{2-}$ (b) Fe^{2+} (c) SO_4^{2-} (d) S^{2-}

76. The most convenient method to protect bottom of ship made of iron is

(a) white tin plating
(b) coating with red lead oxide
(c) connecting with 'Pb' block
(d) connecting with 'Mg' block.

77. One gram of silver gets distributed between 10 cm^3 of molten zinc and 100 cm^3 of molten lead at 800°C. The percentage of silver in the zinc layer is approximately

(Given: Partition coefficient of Ag in Zn and Pb is 300)

(a) 89 (b) 91 (c) 97 (d) 94

78. Main product P of the given reaction is

$CH_3COOH + HCOOH \xrightarrow[570\ K]{MnO} P$

(a) CH_3CHO (b) CH_3COCH_3
(c) HCHO (d) $(CH_3CO)_2O$

79. On passing a current of 1.0 ampere for 16 min and 5 seconds through 1 L solution of $CuCl_2$, all copper of the solution was deposited at cathode. The molarity of $CuCl_2$ solution was

(a) 0.1 M (b) 0.01 M
(c) 0.005 M (d) 0.2 M

80. For the reaction $3A_{(g)} + B_{(g)} \rightleftharpoons 2C_{(g)}$, at a given temperature, $K_c = 9.0$. What must be the volume of the flask, if a mixture of 2.0 mol each of A, B and C exist in equilibrium?

(a) 6 L (b) 9 L
(c) 36 L (d) None of these

SECTION-III (ENGLISH AND LOGICAL REASONING)

Directions (Questions 81 to 84) : *Read the passage and choose the correct option for the questions that follow.*

The avowed purpose of the exact sciences is to establish complete intellectual control over experience in terms of precise rules which can be formally set out and empirically tested. Could that ideal be fully achieved, all truth and all error could henceforth be ascribed to an exact theory of the universe, while we who accept this theory would be relieved of any occasion for exercising our personal judgement. We should only have to follow the rules faithfully. Classical mechanics approaches this ideal so closely that it is often thought to have achieved it. But this leaves out of account the element of personal judgement involved in applying the formulae of mechanics to the facts of experience.

81. In exact sciences, _____ .

(a) personal judgements are set aside in favour of a mechanical theory
(b) one reposes faith in actual experience
(c) one does not find answers to all questions and problems
(d) one interprets the universe according to one's wish

82. The purpose of the exact sciences is to _____ .

(a) form opinions about our experience
(b) assert our intellectual superiority
(c) formulate principles which will help us to exercise our personal judgement
(d) make formal and testable rules which can help verify experience

83. An exact theory of the universe is _____ .

(a) yet to be made (b) possible
(c) not desirable (d) improbable

84. Classical mechanics _____ .

(a) has formulated precise rules
(b) has formulated an exact theory of the universe
(c) has gained intellectual control over the world
(d) just falls short of achieving intellectual control over experience

Directions (Questions 85 to 88) : *Choose the part of the sentence that has an error. If there is no mistake the answer is 'No error'.*

85. Due to me being a newcomer (a) / I was unable to get a house (b) / suitable for my wife and me. (c) / No error (d).

86. Satyajit Ray, who conceived, co-authored (a) / and directed a number of good films was (b) / one of India's most talented film maker. (c) / No error (d).

87. My brother-in-laws (a) / who live in Bombay (b) / have come to stay with us. (c) / No error (d).

88. By all standards (a) / he is a best soldier (b) / our military school (c) / has produced so far (d).

Directions (Questions 89 and 90) : *Choose the correct synonym of the given word.*

89. Wrath

(a) Anger (b) Peace
(c) Jealously (d) Ease

90. Exorbitant
(a) Excessive (b) Threatening
(c) Odd (d) Ridiculous

Directions (Questions 91 to 93) : *Choose the correct option to fill in the blanks.*

91. Contemporary economic development differs _____ from the Industrial Revolution of the 19th century.
(a) literally (b) specially
(c) naturally (d) markedly

92. Mounting unemployment is the most serious and _____ problem faced by India today.
(a) unpopular (b) intractable
(c) dubious (d) profound

93. Ravi's behaviour is worthy of _____ by all the youngsters.
(a) following (b) exploration
(c) trial (d) emulation

Directions (Questions 94 and 95) : *Choose the correctly spelt word.*

94. (a) Extreneous (b) Pregmatic
(c) Squander (d) Dilapedate

95. (a) Eulogise (b) Parsimonous
(c) Disparege (d) Capircious

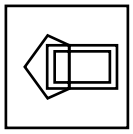
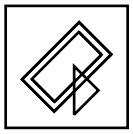
96. Which of the following does not fit in the series given below?

$\frac{3}{\sqrt{3}}, \frac{5}{3}, \frac{7}{3\sqrt{3}}, 1, \frac{11}{6\sqrt{3}}$

(a) $\frac{5}{3}$ (b) $\frac{7}{3\sqrt{3}}$ (c) 1 (d) $\frac{11}{6\sqrt{3}}$

97. If '$A + B$' means 'A is the father of B' and '$A - B$' means 'A is the mother of B' then for $P - Q + S$, which of the following relation is true?
(a) P is grandfather of S
(b) S is grand-daughter of P
(c) S is grandchild of P
(d) S is grandson of P

98. Select the odd one out.

(a)  (b) 

(c)  (d) 

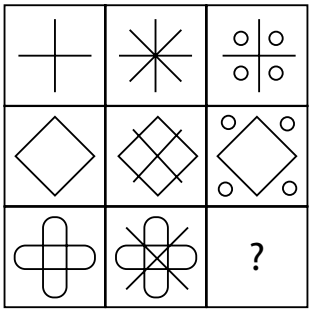
99. The given (X), shows the manner in which a sheet of paper has been folded either once or more than once and hence has been cut. You have to select a figure from the options that would show the pattern like as the given figure (sheet) in unfolded form.

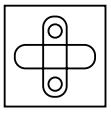
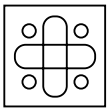

Fig. (X)

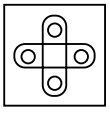
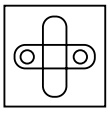
(a)  (b) 

(c)  (d) 

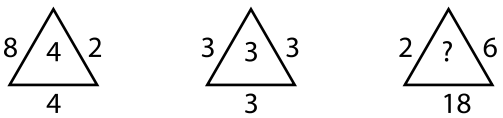
100. Which of the following figures will complete the given figure matrix?



(a)  (b) 

(c)  (d) 

101. Find the missing number, if same rule is followed in all the three figures.



(a) 6 (b) 7 (c) 8 (d) 9

102. If $2 \Delta 3 = 8.5$, $4 \Delta 9 = 42.5$, $8 \Delta 6 = 55$, then $18 \Delta 37 = ?$
(a) 61 (b) 93.5
(c) 693.5 (d) 642

103. If 'Δ' stands for '+', '$\bigcirc$' stands for '–', '$\square$' stands for '×' and '$\star$' stands for '÷', then which of the following is correct?
(a) $8 \star 2 \square 4 \bigcirc 2 \square 2 \square 2 \square 2 = 2$
(b) $14 \star 2 \bigcirc 8 \Delta 2 \square 6 = 10$
(c) $13 \bigcirc 7 \Delta 3 \square 3 \star 3 = 9$
(d) $9 \bigcirc 5 \square 4 \Delta 28 \star 4 = 4$

104. Select the correct water image of the given Fig. (*X*).

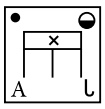
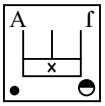
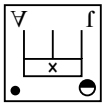
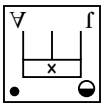
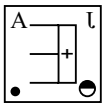


Fig. (*X*)

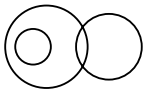
(a) 

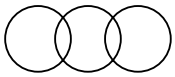
(b) 

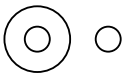
(c) 

(d) 

105. Which of the following Venn diagrams best represents the relationship amongst, "Males, Females and Brothers"?

(a) 

(b) 

(c) 

(d) 

SECTION-IV (MATHEMATICS)

106. If $f: R \to R$ is defined by $f(x) = x - [x] - \frac{1}{2} \forall x \in R$ where $[x]$ denotes the greatest integer function, then $\left\{x \in R : f(x) = \frac{1}{2}\right\}$ is

(a) Z, the set of all integers
(b) N, the set of all natural numbers
(c) ϕ, the empty set
(d) R, the set of all real numbers

107. Let $f(x) = \frac{(x^2+1)(\log_2 x - 1)(x-3)^2 x}{(x-1)^3}$ the set of all values of x so that $f(x)$ less than or equal to zero is

(a) $(-\infty, -1] \cup (1, 2] \cup \{3\}$
(b) $(-2, 3] \cup \{3\}$
(c) $(-2, 2] - \{3\}$
(d) $x \in (1, 2)$

108. The circle $x^2 + y^2 = 16$ touches the sides BC, CA and AB of ΔABC respectively at D, E and F. If the lengths BD, CE and AF are consecutive integers then the largest side of the triangle is equal to

(a) 13 (b) 14
(c) 15 (d) cannot be determined

109. Let $P(n) : n^2 + n$ is an odd integer and $P(k) \Rightarrow P(k+1)$ is true, $P(n)$ is true for all

(a) $n > 2$ (b) $n > 1$
(c) n (d) none of these

110. The complex numbers $z = x + iy$ which satisfy the equation $\left|\frac{z-5i}{z+5i}\right| = 1$, lie on

(a) x-axis
(b) straight line $y = 5$
(c) a circle passing through the origin
(d) none of these.

111. If $(x-1)(3-x)(x-2)^2 > 0$, then x belongs to

(a) $(1, 2) \cup (2, 3)$ (b) $(-1, 2) \cup (2, 3)$
(c) $(1, 0) \cup (2, 3)$ (d) none of these.

112. A five digit number divisible by 3 is to be formed using the numerals 0, 1, 2, 3, 4 and 5 without repetition. The total number of ways in which this can be done is

(a) 216 (b) 240 (c) 600 (d) 3125

113. The distance between the point (1, 2) and the point of intersection of the lines $2x + y = 2$ and $x + 2y = 2$ is

(a) $\frac{\sqrt{17}}{3}$ (b) $\frac{\sqrt{16}}{3}$ (c) $\frac{\sqrt{17}}{5}$ (d) $\frac{\sqrt{19}}{3}$

114. Sum of the series $\frac{1^3}{1} + \frac{1^3+2^3}{1+3} + \frac{1^3+2^3+3^3}{1+3+5}$ ... to 16 terms is

(a) 346 (b) 446
(c) 546 (d) none of these.

115. Let PQR be a right angled isosceles triangle, right angled at $P(2, 1)$. If the equation of the line QR is $2x + y = 3$, then the equation representing the pair of lines PQ and PR is

(a) $3x^2 - 3y^2 + 8xy + 20x + 10y + 25 = 0$
(b) $3x^2 - 3y^2 + 8xy - 20x - 10y + 25 = 0$
(c) $3x^2 - 3y^2 + 8xy + 10x + 15y + 20 = 0$
(d) $3x^2 - 3y^2 - 8xy - 10x - 15y - 20 = 0$

116. The area of the triangle inscribed in an ellipse bears the ratio $\sqrt{5}:3$ to the area of the triangle formed by joining points on the auxiliary circle corresponding to the vertices of the first triangle, then the eccentricity of the ellipse is

(a) 2/3 (b) 3/4 (c) $\sqrt{5}/3$ (d) 3/5

117. If $\lim_{x \to -\infty} \left(\sqrt{x^6 + ax^5 + bx^3 - cx + d} - \sqrt{x^6 - 2x^5 + x^3 + x + 1}\right) = 2$ then

(a) $b = -2$ (b) $a = -2$
(c) $a = 2$ (d) $b = 5$

118. Statement I : $\sim(p \leftrightarrow \sim q)$ is equivalent to $p \leftrightarrow q$.
Statement II : $\sim(p \leftrightarrow \sim q)$ is a tautology.

(a) Statement I is true, Statement II is true; Statement II is a correct explanation for Statement I.
(b) Statement I is true, Statement II is true; Statement II is not a correct explanation for Statement I.
(c) Statement I is true, Statement II is false.
(d) Statement I is false, Statement II is true.

119. If a variable x takes values x_i such that $a \le x_i \le b$, for $i = 1, 2, ..., n$, then

(a) $a^2 \le \text{var}(x) \le b^2$ (b) $a \le \text{var}(x) \le b$

(c) $\frac{a^2}{4} \le \text{var}(x)$ (d) $(b - a)^2 \ge \text{var}(x)$

120. From a set of 40 cards numbered 1 to 40, 5 cards are drawn at random and arranged in ascending order of magnitude $x_1 < x_2 < x_3 < x_4 < x_5$. The probability $x_3 = 24$, is

(a) $\frac{{}^{16}C_2}{{}^{40}C_5}$ (b) $\frac{{}^{23}C_2}{{}^{40}C_5}$

(c) $\frac{{}^{16}C_2 \times {}^{23}C_2}{{}^{40}C_5}$ (d) none of these

121. If $g(f(x)) = |\sin x|$ and $f(g(x)) = (\sin\sqrt{x})^2$, then

(a) $f(x) = \sin^2 x$, $g(x) = \sqrt{x}$

(b) $f(x) = \sin x$, $g(x) = |x|$

(c) $f(x) = x^2$, $g(x) = \sin\sqrt{x}$

(d) f and g cannot be determined

122. The value of

$$\cot^{-1}\left(2^2 + \frac{1}{2}\right) + \cot^{-1}\left(2^3 + \frac{1}{2^2}\right) + \cot^{-1}\left(2^4 + \frac{1}{2^3}\right) + \ldots \infty$$

(a) $\tan^{-1}2$ (b) $\cot^{-1}2$

(c) $\pi/4$ (d) none of these

123. If $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$ satisfies the equation $x^2 - (a + d)x + k = 0$, then

(a) $k = bc$ (b) $k = ad$

(c) $k = a^2 + b^2 + c^2 + d^2$ (d) $ad - bc$

124. If $\begin{vmatrix} 1+\sin^2\theta & \cos^2\theta & 4\sin 4\theta \\ \sin^2\theta & 1+\cos^2\theta & 4\sin 4\theta \\ \sin^2\theta & \cos^2\theta & 1+4\sin 4\theta \end{vmatrix} = 0$,

then θ is equal to

(a) $\frac{7\pi}{24}, \frac{11\pi}{24}$ (b) $\frac{5\pi}{24}, \frac{7\pi}{24}$

(c) $\frac{11\pi}{24}, \frac{\pi}{24}$ (d) $\frac{\pi}{24}, \frac{7\pi}{24}$

125. Given $f(x) = \begin{cases} x^2 e^{2(x-1)}, & 0 \le x \le 1 \\ a\cos(2x-2) + bx^2, & 1 < x \le 2 \end{cases}$ $f(x)$ is differentiable at $x = 1$ provided

(a) $a = -1$, $b = 2$ (b) $a = 1$, $b = -2$

(c) $a = -3$, $b = 4$ (d) $a = 3$, $b = -4$

126. Let $f(x) = \int e^x (x-1)(x-2)dx$, then f decreases in the interval

(a) $(-\infty, -2)$ (b) $(-2, -1)$

(c) $(1, 2)$ (d) $(2, \infty)$

127. The value of $\int_0^{\sin^2 x} \sin^{-1}\sqrt{t}\,dt + \int_0^{\cos^2 x} \cos^{-1}\sqrt{t}\,dt$ is

(a) $\frac{\pi}{2}x$ (b) x^2

(c) $\frac{\pi}{4}x^3$ (d) none of these

128. The area bounded by the curves $y = (x - 1)^2$, $y = (x + 1)^2$ and $y = \frac{1}{4}$ is

(a) $\frac{1}{3}$ sq. unit (b) $\frac{2}{3}$ sq. unit

(c) $\frac{1}{4}$ sq. unit (d) $\frac{1}{5}$ sq. unit

129. Solution of the equation $xdy = \left(y + x\frac{f(y/x)}{f'(y/x)}\right)dx$ is

(a) $f\left(\frac{x}{y}\right) = cy$ (b) $f\left(\frac{y}{x}\right) = cx$

(c) $f\left(\frac{y}{x}\right) = cxy$ (d) $f\left(\frac{y}{x}\right) = 0$

130. Let $\vec{a}, \vec{b}, \vec{c}$ be three non-coplanar vectors and $\vec{d}$ be a non-zero vector, which is perpendicular to $\vec{a} + \vec{b} + \vec{c}$. Now, if $\vec{d} = (\sin x)(\vec{a} \times \vec{b}) + (\cos y)(\vec{b} \times \vec{c}) + 2(\vec{c} \times \vec{a})$, then minimum value of $x^2 + y^2$ is equal to

(a) π^2 (b) $\frac{\pi^2}{2}$ (c) $\frac{\pi^2}{4}$ (d) $\frac{5\pi^2}{4}$

131. The equation of the line passing through (1, 2, 3) and perpendicular to $3x + 4y - 5z = 6$ is

(a) $\frac{x-1}{3} = \frac{2-y}{4} = \frac{3-z}{5}$

(b) $\frac{x-1}{3}=\frac{y-2}{4}=\frac{3-z}{5}$

(c) $\frac{x-3}{1}=\frac{y-4}{2}=\frac{z+5}{3}$

(d) $\frac{1-x}{3}=\frac{y-2}{4}=\frac{z-3}{-5}$

132. $Z = 8x + 10y$, subject to $2x + y \geq 7$, $2x + 3y \geq 15$, $y \geq 2$, $x \geq 0$, $y \geq 0$. The minimum value of Z occurs at

(a) (4.5, 2) (b) (1.5, 4) (c) (0, 7) (d) (7, 0)

133. A box has n coins, m of which are fair and the rest are biased, the probability of getting head on biased coin is 2/3. A coin is drawn from the box at random and is tossed twice. The first time it shows head and the second time it shows tail. Then the probability that the coin drawn is fair is

(a) $\frac{m}{m+8n}$ (b) $\frac{3m}{m+8n}$

(c) $\frac{9m}{m+8n}$ (d) $\frac{n}{8m+n}$

134. The solution of $\sin^3\theta\cos\theta - \sin\theta\cos^2\theta = \frac{1}{4}$ is

(a) $\frac{n\pi}{4}+\frac{\pi}{8}$ (b) $\frac{n\pi}{4}+(-1)^{n+1}\frac{\pi}{8}$

(c) $\frac{n\pi}{2}\pm\frac{\pi}{8}$ (d) $\frac{n\pi}{4}+(-1)^{n}\frac{\pi}{8}$

135. If $\log_{\sqrt{3}}\left(\frac{|z|^2-|z|+1}{2+|z|}\right)<2$, then the locus of z is

(a) $|z| = 5$ (b) $|z| < 5$

(c) $|z| > 5$ (d) none of these.

136. The determinant $\begin{vmatrix} a & b & a\alpha+b \\ b & c & b\alpha+c \\ a\alpha+b & b\alpha+c & 0 \end{vmatrix}$ is equal to zero if

(a) a, b, c are in A.P. (b) a, b, c are in G.P.

(c) a, b, c are in H.P. (d) none of these.

137. Consider a parallelogram whose sides are represented by the lines $2x + 3y = 0$; $2x + 3y - 5 = 0$; $3x - 4y = 0$ and $3x - 4y = 3$. The equation of the diagonal not passing through the origin, is

(a) $21x - 11y + 15 = 0$ (b) $9x - 11y + 15 = 0$

(c) $21x - 29y - 15 = 0$ (d) $21x - 11y - 15 = 0$

138. A normal to the hyperbola $x^2 - 4y^2 = 4$ has equal intercepts on positive x and y axes. If this normal touches the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ then $a^2 + b^2$ is equal to

(a) 5 (b) 16 (c) 25/9 (d) 16/9

139. Number of integer elements in range of the function $f: (-\infty, 1) \to R$, defined by $f(x) = [9^x - 3^x + 1]$, [.] denotes greatest integer function

(a) 2 (b) 3

(c) 4 (d) None of these

140. If $(\tan^{-1}x)^2 + (\cot^{-1}x)^2 = \frac{5\pi^2}{8}$, then x equals

(a) 0 (b) –1 (c) –2 (d) –3

141. The determinant $\begin{vmatrix} {}^xC_1 & {}^xC_2 & {}^xC_3 \\ {}^yC_1 & {}^yC_2 & {}^yC_3 \\ {}^zC_1 & {}^zC_2 & {}^zC_3 \end{vmatrix} =$

(a) $\frac{1}{3}xyz(x + y)(y + z)(z + x)$

(b) $\frac{1}{4}xyz(x + y - z)(y + z - x)$

(c) $\frac{1}{12}xyz(x - y)(y - z)(z - x)$

(d) none of these

142. $f(x)=\begin{cases} \alpha+\frac{\sin[x]}{x} & , \quad x>0 \\ 2 & , \quad x=0 \\ \beta+\left[\frac{\sin x-x}{x^3}\right] & , \quad x<0 \end{cases}$

Where [.] is G.I.F. If $f(x)$ is continuous at $x = 0$ then $\beta - \alpha$ equal to

(a) 1 (b) –1 (c) 2 (d) –2

143. $\int\left(x+\frac{1}{x}\right)^{n+5}\left(\frac{x^2-1}{x^2}\right)dx$ is equal to

(a) $\frac{\left(x+\frac{1}{x}\right)^{n+6}}{n+6}+c$

(b) $\left(\frac{x^2+1}{x^2}\right)^{n+6}(n+6)+c$

(c) $\left(\frac{x}{x^2+1}\right)^{n+6}(n+6)+c$

(d) none of these

144. Tangent is drawn to ellipse $\frac{x^2}{27}+y^2=1$ at $(3\sqrt{3}\cos\theta, \sin\theta)$ (where $\theta \in (0, \pi/2)$).

Then, the value of θ such that the sum of intercepts on axes made by this tangent is minimum, is

(a) $\frac{\pi}{3}$ (b) $\frac{\pi}{6}$

(c) $\frac{\pi}{8}$ (d) $\frac{\pi}{4}$

145. The solution of $\frac{dy}{dx}=\frac{1}{2x-y^2}$ is given by $x = cg(y) + ay^2 + by + d$ where c, a, b, d are constants then $a + b + d$ is

(a) $\frac{1}{4}$ (b) $\frac{3}{4}$

(c) $\frac{5}{4}$ (d) none of these

146. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be the three vectors having magnitudes 1, 5 and 3 respectively such that the angle between $\vec{a}$ and $\vec{b}$ is θ and $\vec{a}\times(\vec{a}\times\vec{b})=\vec{c}$, then tanθ is equal to

(a) 0 (b) 2/3 (c) 3/5 (d) 3/4

147. The locus of a point which moves in such a way that its distance from the line $\frac{x}{1}=\frac{y}{1}=\frac{z}{-1}$ is twice the distance from the plane $x + y + z = 0$ is

(a) $x^2 + y^2 + z^2 - 5x - 3y - 3z = 0$

(b) $x^2 + y^2 + z^2 + 5x + 3y + 3z = 0$

(c) $x^2 + y^2 - z^2 - 5xy - 3yz - 3zx = 0$

(d) $x^2 + y^2 - z^2 + 5xy + 3yz + 3zx = 0$

148. The equation $2x^2 - (1 + 2a)x + 1 + a = 0$ has integral roots when a assumes the integral values

(a) −1, 0 (b) −1, 1 (c) −2, 0 (d) −1, 2

149. An isosceles triangle with base 24 and legs 15 each is inscribed in a circle with centre at (−1, 1), then locus of the centroid of that Δ is

(a) $4(x^2 + y^2) + 8x - 8y - 73 = 0$

(b) $2(x^2 + y^2) + 4x - 4y - 31 = 0$

(c) $2(x^2 + y^2) + 4x - 4y - 21 = 0$

(d) $4(x^2 + y^2) + 8x - 8y - 161 = 0$

150. In how many ways can a committee be formed of 5 members from 6 men and 4 women if the committee has at least one woman?

(a) 186 (b) 246 (c) 252 (d) 236

SOLUTIONS

1. (d): Maximum height for mass m_1, $H_1=\frac{u^2\sin^2\theta}{2g}$

and $H_2=\frac{u^2\sin^2(90^\circ-\theta)}{2g}$,

for mass m_2,

$\therefore \quad \frac{H_1}{H_2}=\frac{\sin^2\theta}{\sin^2(90^\circ-\theta)}=\frac{\sin^2\theta}{\cos^2\theta}=\frac{\tan^2\theta}{1}$

$\therefore \quad H_1 : H_2 = \tan^2\theta : 1.$

2. (b): Let k be spring constant of the spring.

When the mass M is suspended from the spring, let it be stretched by distance y.

$\therefore \quad Mg = ky$ ...(i)

Now when the additional mass m is added to it, it stretches further the distance x.

$\therefore \quad (M + m)g = k(x + y)$ ...(ii)

Subtracting eqn. (i) from eqn. (ii), we get

$(M + m)g - Mg = k(x + y) - ky$

$mg = kx \quad \text{or} \quad k=\frac{mg}{x}$ ...(iii)

Therefore, period of the combined mass is

$T=2\pi\sqrt{\frac{(M+m)}{k}}=2\pi\sqrt{\frac{(M+m)}{(mg/x)}}$ (using (iii))

$=2\pi\sqrt{\frac{(M+m)x}{mg}}$

3. (a): (i) Let a be the common acceleration and mass of three blocks is $3m$. Then

$F = 3m \times a \quad \text{or} \quad a = F/3m$

(ii) Net force on the block A will be

$F_1=m\times a=m\times\frac{F}{3m}=\frac{F}{3}$

(iii) Force applied by block A on B,

$F_2=(m_1+m_2)a=2m\times\frac{F}{3m}=\frac{2F}{3}$

(iv) Force applied by block B on C,

$F_3=m\times a=m\times\frac{F}{3m}=\frac{F}{3}$

4. (c)

5. (d): Number of atoms present in a radioactive substance is $N_0=\left(\frac{m}{M}\right)N_A$

where m is the mass of the substance, M its molecular weight and N_A is Avogadro number.

As $m = V\rho$

$\therefore \quad N_0=\left(\frac{V\rho}{M}\right)N_A$ ...(i)

The activity of the substance after time t is

$R=\lambda N=\lambda N_0e^{-\lambda t}$ $(\because N=N_0e^{-\lambda t})$

$R=\lambda\left(\frac{V\rho}{M}\right)N_Ae^{-\lambda t}$ (using (i))

$R=\left(\frac{\lambda V\rho N_A}{M}\right)e^{-\lambda t}$

6. (c) : As $\vec{r} = (4\cos 2t)\,\hat{i} + (4\sin 2t)\,\hat{j} + 6t\,\hat{k}$,

Velocity, $\vec{v} = \frac{d\vec{r}}{dt} = [4(-\sin 2t).(2)]\hat{i} + [4(\cos 2t).(2)]\hat{j} + 6\hat{k}$

$= (-8\sin 2t)\hat{i} + (8\cos 2t)\hat{j} + 6\hat{k}$

Acceleration, $\vec{a} = \frac{d\vec{v}}{dt}$

$= [-8(\cos 2t)(2)]\hat{i} + [8(-\sin 2t)(2)]\hat{j}$

$= (-16\cos 2t)\hat{i} + (-16\sin 2t)\hat{j}$

When $t = \pi/4$ s,

$\vec{a} = (-16\cos\pi/2)\hat{i} + (-16\sin\pi/2)\hat{j}$

$= (-16\times 0)\hat{i} + (-16\times 1)\hat{j} = -16\hat{j}$ m s^{-2}

7. (d) : Displacement = velocity × time. In time 0 to 2 T, the displacement = – Area of ΔOAD + Area of ΔDBC = 0. Initial and final speeds are the same as per graph.

The slope of velocity-time graph represents acceleration. Here, the velocity-time graph is a straight line inclined to time axis, hence has equal acceleration throughout the motion. The particle changes its direction of motion after time T.

8. (a) : The magnetisation of a paramagnetic sample is

$M = C\frac{B}{T}$

where B is the external magnetic field, T is the absolute temperature and C is the Curie's constant.

$\therefore \quad \frac{M_1}{M_2} = \frac{CB_1/T_1}{CB_2/T_2} = \left(\frac{B_1}{B_2}\right)\left(\frac{T_2}{T_1}\right)$

$M_2 = M_1\left(\frac{B_2}{B_1}\right)\left(\frac{T_1}{T_2}\right)$

$= (0.8\text{ A m}^{-1})\left(\frac{0.4\text{ T}}{0.8\text{ T}}\right)\left(\frac{5\text{ K}}{20\text{ K}}\right) = 0.1\text{ A m}^{-1}$

9. (c) : The drift speed is $v_d = \frac{I}{neA}$

where n is the number density of electrons and A is the area of cross-section of the conductor.

For steady current, $v_d \propto \frac{1}{A}$

As A increases from P to Q, so v_d decreases from P to Q.

10. (a) : Required percentage error

$= \left(\frac{0.1}{5} + \frac{0.1}{10} + \frac{0.1}{5}\right)\times 100 = 5\%$

11. (a) : Here, $A_{max} = 10$ V, $\mu = \frac{2}{3}$

Modulation index, $\mu = \frac{A_{max} - A_{min}}{A_{max} + A_{min}}$

$\frac{2}{3} = \frac{10\text{ V} - A_{min}}{10\text{ V} + A_{min}}$

$5A_{min} = 10\text{ V}$ or $A_{min} = 2$ V

12. (a) : If I_0 is the intensity of unpolarised light, then intensity of light transmitted through first polariser is $I_1 = \frac{I_0}{2}$

Intensity of light transmitted through second polariser is

$I_2 = I_1\cos^2\theta$

(where θ is the angle between axes of two polarisers)

$= \frac{I_0}{2}\cos^2 45° = \frac{I_0}{2}\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{I_0}{4}$

13. (d) : The magnitude of electric and magnetic fields in an electromagnetic wave are related as $B_0 = \frac{E_0}{c}$

Thus, $\frac{E_0}{B_0} = c$

where c is the velocity of electromagnetic wave in free space.

14. (b) : Power $P = \frac{W}{t} = \frac{Fs}{t} = \frac{mas}{t}$ $(\because F = ma)$

$P = \frac{mvs}{t^2}$, $\left(\because a = \frac{v}{t}\right)$

$P = \frac{ms^2}{t^3}$ $\left(\because v = \frac{s}{t}\right)$

or $Pt^3 = ms^2$

$\therefore \quad s \propto t^{3/2}$

15. (b) : Here,

$L = 0.01$ H, $R = \sqrt{3}\pi\,\Omega$, $\upsilon = 50$ Hz

The inductive reactance is

$X_L = \omega L = 2\pi\upsilon L = 2\pi(50\text{ Hz})(0.01\text{ H}) = \pi\,\Omega$

The phase difference ϕ between the current and the voltage is

$\phi = \tan^{-1}\left(\frac{X_L}{R}\right)$ $\left(\text{as } \tan\phi = \frac{X_L}{R}\right)$

$= \tan^{-1}\left(\frac{\pi\,\Omega}{\sqrt{3}\pi\,\Omega}\right) = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right) = 30° = \frac{\pi}{6}$

16. (b) : Here $m = 2$ kg, $h = 1$ m, $k = 490$ N m^{-1}

Let the spring be compressed through distance x. Then the block falls through a height $(h + x)$.

Gain in P.E. of the spring = Loss in P.E. of the block

$$\frac{1}{2}kx^2 = mg(h+x)$$

or $\frac{1}{2}\times 490\times x^2 = 2\times 9.8\times(1+x)$

or $12.5\,x^2 - x - 1 = 0$

$$\therefore \quad x = \frac{1\pm\sqrt{1+4\times 12.5}}{2\times 12.5} = \frac{1\pm\sqrt{51}}{25} = 0.33 \text{ m}$$

17. (d): The filament resistance at 0°C is

$R_0 = 4\ \Omega$ (given)

and at 425°C is

$$R_{425} = \frac{3.5\text{ V}}{0.28\text{ A}} = 12.5\,\Omega$$

Let α be required temperature coefficient of resistance.

As $R_T = R_0(1 + \alpha T)$

$$\therefore \quad \alpha = \frac{R_T - R_0}{R_0 T} = \frac{R_{425} - R_0}{R_0(425°\text{C})}$$

$$= \frac{12.5\,\Omega - 4\,\Omega}{4\,\Omega(425°\text{C})} = 5\times 10^{-3}\ °\text{C}^{-1}$$

18. (a): The magnitude of electric field intensity due to an infinitely long straight wire of uniform linear charge density λ is

$$E = \frac{\lambda}{2\pi\varepsilon_0 r} = \frac{1}{4\pi\varepsilon_0}\frac{2\lambda}{r}$$

where r is the perpendicular distance of the point from the wire.

Here, $\lambda = \frac{1}{3}\text{ C m}^{-1}$, $r = 18\text{ cm} = 18\times 10^{-2}$ m,

$$\frac{1}{4\pi\varepsilon_0} = 9\times 10^9\ \text{N m}^2\ \text{C}^{-2}$$

$$\therefore \quad E = \frac{(9\times 10^9\ \text{N m}^2\text{C}^{-2})(2)\left(\frac{1}{3}\text{C m}^{-1}\right)}{(18\times 10^{-2}\text{ m})}$$

$$= \frac{1}{3}\times 10^{11}\text{N C}^{-1} = 0.33\times 10^{11}\ \text{N C}^{-1}$$

19. (c): The efficiency of the engine is

$$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{375}{500} = 25\%.$$

Heat consumed per cycle, $Q_1 = 600$ kcal

$\therefore$ Heat rejected to the sink per cycle is

$Q_1 - \eta Q_1 = 600 - 0.25\times 600 = 450$ kcal

20. (b): As $h = \left(\frac{T^2R^2}{4\pi^2}g\right)^{1/3} - R$

$$= \left[\frac{(24\times 60\times 60)^2\times(6.4\times 10^6)^2\times 9.8}{4\times(22/7)^2}\right]^{1/3} - 6.4\times 10^6$$

$= 3.6\times 10^7$ m $= 36000$ km

21. (d)

22. (a): Number of waves in glass slab is

$$N_1 = \frac{\text{Thickness of glass slab}}{\text{Wavelength of light in glass}} = \frac{8\text{ cm}}{\lambda_{\text{glass}}}$$

Number of waves in water is

$$N_2 = \frac{\text{Length of path of water}}{\text{Wavelength of light in water}} = \frac{10\text{ cm}}{\lambda_{\text{water}}}$$

As $N_1 = N_2$ (given)

$$\therefore \quad \frac{8\text{ cm}}{\lambda_{\text{glass}}} = \frac{10\text{ cm}}{\lambda_{\text{water}}}$$

$$\text{or} \quad \frac{\lambda_{\text{glass}}}{\lambda_{\text{water}}} = \frac{8\text{ cm}}{10\text{ cm}} = \frac{4}{5} \qquad \ldots(i)$$

As refractive index of a medium,

$$\mu = \frac{\text{Wavelength of light in vacuum}}{\text{Wavelength of light in medium}}$$

$$\therefore \quad \frac{\mu_{\text{glass}}}{\mu_{\text{water}}} = \frac{\lambda_{\text{water}}}{\lambda_{\text{glass}}} \qquad \left[\because \mu\times\frac{1}{\lambda}\right]$$

$$\text{or } \mu_{\text{glass}} = \frac{\lambda_{\text{water}}}{\lambda_{\text{glass}}}\mu_{\text{water}} = \left(\frac{5}{4}\right)\left(\frac{4}{3}\right) = \frac{5}{3} \text{ (using (i))}$$

23. (c): Let T_1 be the time period of longer pendulum

$$\therefore \quad \frac{T_1}{T} = \sqrt{\frac{l_1}{l}} = \sqrt{\frac{16}{1}} = 4 \quad \text{or} \quad T_1 = 4T$$

Let after time t, the pendulum be in the same phase. It will be so then

$$\frac{t}{T_1} = \frac{t}{T} - 1 = \frac{t-T}{T} \quad \text{or} \quad \frac{t}{4T} = \frac{t-T}{T}$$

or $t = 4t - 4T$ or $3t = 4T$ $\therefore$ $t = 4T/3$

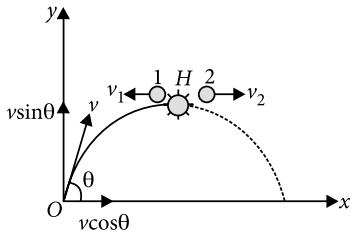
24. (b): Here,

Change in collector current, $\Delta I_C = 2$ mA

Current amplification factor, $\beta = 50$

$$\text{As } \beta = \frac{\Delta I_C}{\Delta I_B} \quad \therefore \quad \Delta I_B = 40\times 10^{-6}\text{ A} = 40\ \mu\text{A}$$

25. (c): The flight of the shell before explosion is shown in figure where H is the highest point.



Velocity of the shell at $H = v\cos\theta$

At H, it explodes into two pieces each of mass $m/2$ and denoted by 1 and 2 respectively. Let v_1 and v_2 be velocities of the pieces 1 and 2 immediately after the explosion.

As the piece 1 retraces its path to the cannon,

$\therefore \quad v_1 = -v\cos\theta$

Applying the law of conservation of momentum,

$$mv\cos\theta = \frac{m}{2}v_1 + \frac{m}{2}v_2$$

$$mv\cos\theta = \frac{m}{2}(-v\cos\theta) + \frac{m}{2}v_2$$

$$v_2 = 3v\cos\theta$$

26. (b)

27. (d): The given transition $n = 2$ to $n = 1$ corresponds to first line of Lyman series.

For Lyman series,

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{n^2}\right] \text{ where } n = 2, 3, 4, ...$$

For first line, $n = 2$

$$\therefore \quad \frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \frac{3}{4}R \qquad \text{... (i)}$$

For minimum wavelength of the series, $n = \infty$

$$\therefore \quad \frac{1}{\lambda_{min}} = R\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right] = R \qquad \text{... (ii)}$$

Dividing eqn. (i) by eqn. (ii), we get

$$\frac{\lambda_{min}}{\lambda} = \frac{3}{4} \quad \text{or} \quad \lambda_{min} = \frac{3}{4}\lambda$$

But $\lambda = 122$ nm (given)

$$\therefore \quad \lambda_{min} = \frac{3}{4}(122 \text{ nm}) = 91.5 \text{ nm} = 915 \text{ Å}$$

28. (b): Here, $u_1 = 12 \text{ m s}^{-1}$, $u_2 = 10 \text{ m s}^{-1}$

Let v_1 be velocity of the light particle after collision

$$v_1 = \frac{(m_1 - m_2)u_1}{m_1 + m_2} + \frac{2m_2u_2}{m_1 + m_2} \qquad \text{...(i)}$$

Given : $m_1 << m_2$

m_1 can be ignored compared to m_2

From equation (i), we get

$v_1 = -u_1 + 2u_2$

Substituting the values, we get

$v_1 = -12 \text{ m s}^{-1} + 2\,(10 \text{ m s}^{-1})$

$= 8 \text{ m s}^{-1}$ in its original direction

29. (c): Here, velocity of bat, $v_s = 4 \text{ m s}^{-1}$

velocity of sound, $v = 340 \text{ m s}^{-1}$

Frequency emitted by the bat, $\upsilon = 90$ kHz

As source (bat) is moving towards the wall, the apparent frequency of sound striking the wall is

$$\upsilon' = \upsilon\left[\frac{v}{v - v_s}\right] \qquad \text{....(i)}$$

On reflection, wall acts as source and bat is the observer

$$\therefore \quad \upsilon'' = \upsilon'\left[\frac{v + v_o}{v}\right] = \upsilon\left[\frac{v + v_o}{v - v_s}\right] \qquad \text{[Using (i)]}$$

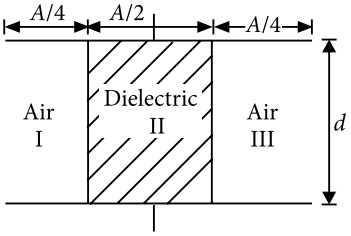
$$= 90\left[\frac{340 + 4}{340 - 4}\right] = \frac{90 \times 344}{336} = 92.1 \text{ kHz}$$

30. (d): Capacitance of a parallel plate capacitor filled with air is

$$C = \frac{\varepsilon_0 A}{d} = 10\ \mu\text{F (given)} \qquad \text{... (i)}$$

where d is the distance between the plates.

When the gap between the plates is filled partly with a dielectric of dielectric constant $K(= 4)$ as shown in figure. Then,



Capacitance of part I is $C_1 = \frac{\varepsilon_0(A/4)}{d} = \frac{\varepsilon_0 A}{4d}$

Capacitance of part II is $C_2 = \frac{K\varepsilon_0(A/2)}{d} = \frac{K\varepsilon_0 A}{2d}$

Capacitance of part III is $C_3 = \frac{\varepsilon_0(A/4)}{d} = \frac{\varepsilon_0 A}{4d}$

$\because \quad C_1$, C_2 and C_3 are in parallel.

$\therefore \quad$ The new capacitance of the capacitor is

$C_{new} = C_1 + C_2 + C_3$

$$= \frac{\varepsilon_0 A}{4d} + \frac{K\varepsilon_0 A}{2d} + \frac{\varepsilon_0 A}{4d} = \frac{\varepsilon_0 A}{2d} + \frac{K\varepsilon_0 A}{2d}$$

$$= \frac{\varepsilon_0 A}{2d}(1 + K) = \frac{10\ \mu\text{F}}{2}(1 + 4) = 25\ \mu\text{F} \qquad \text{(using (i))}$$

31. (a) 32. (d) 33. (d) 34. (a) 35. (c)
36. (c) 37. (b) 38. (a) 39. (b) 40. (c)
41. (c)

42. (b): For e.m.f. to be positive, the following half cell reactions will occur :

$Fe \longrightarrow Fe^{2+} + 2e^-$ $\qquad E^\circ = +0.44$ V

$2Fe^{3+} + 2e^- \longrightarrow 2Fe^{2+}$ $\qquad E^\circ = +0.77$ V

Overall reaction :

$Fe + 2Fe^{3+} \longrightarrow 3Fe^{2+}$ $\qquad E^\circ = +1.21$ V

$\therefore \quad Fe^{3+}$ will decrease.

43. (b): % of H $= \frac{2}{18} \times \frac{\text{Mass of } H_2O \text{ formed}}{\text{Mass of compound taken}} \times 100$

$= \frac{2}{18} \times \frac{0.18}{0.2} \times 100 = 10\%$

44. (b)

45. (d): Required equilibrium is obtained if we operate, eq. III. × 4 – eq. I × 2 – eq. II × 2 we get,

$$K_c = \left(\frac{1}{K_{c_1}}\right)^2 \times \left(\frac{1}{K_{c_2}}\right)^2 \times (K_{c_3})^4 = \frac{[N_2O_4]^2}{[N_2O]^2[O_2]^3}$$

$$= \left(\frac{1}{2.7\times10^{-18}}\right)^2 \times \left(\frac{1}{4.6\times10^{-3}}\right)^2 \times (4.1\times10^{-9})^4$$

$= 1.832 \times 10^6$

46. (b) **47. (d)** **48. (d)** **49. (a)**

50. (b):

$$\underset{(P)}{Cu} + \underset{(Q)}{2AgNO_3} \longrightarrow 2Ag + \underset{\text{Blue solution}}{Cu(NO_3)_2} \xrightarrow{NaCl_{(aq)}} \underset{\text{White } (R)}{NaNO_{3(aq)}} + CuCl_{2(aq)}$$

$$\underbrace{[Na(NH_3)]^+ + e^-}_{\text{Blue solution}} \xleftarrow{NH_{3(aq)}} \text{(same)}$$

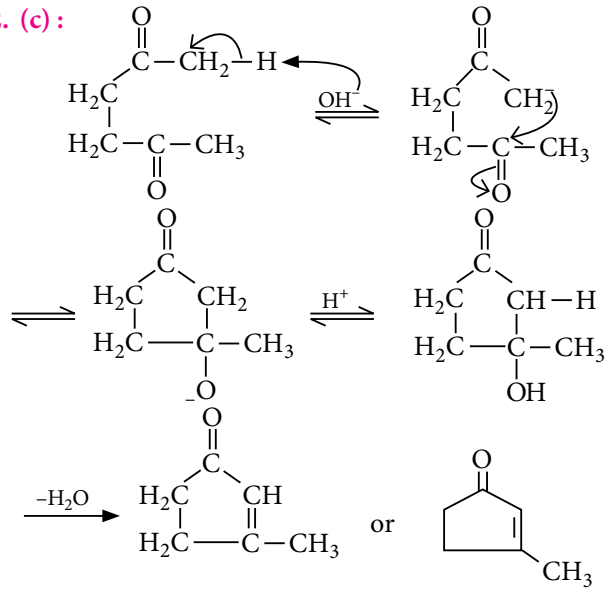
51. (a): $E = \frac{hc}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^8}{\lambda}$

E(given) $= \frac{242\times10^3}{6.02\times10^{23}}$ J per molecule of Cl—Cl bond.

$$\frac{6.6\times10^{-34}\times3\times10^8}{\lambda} = \frac{242\times10^3}{6.02\times10^{23}}$$

$\Rightarrow \quad \lambda = 494$ nm

52. (c):



53. (b): We know, $V = 5.6 \times N$

$N_1 = \frac{10}{5.6}$; $N_2 = \frac{15}{5.6}$; $N_3 = \frac{20}{5.6}$

$N_1V_1 + N_2V_2 + N_3V_3 = N_RV_R$

$$\frac{10}{5.6}\times\frac{1}{2} + \frac{15}{5.6}\times\frac{1}{2} + \frac{20}{5.6}\times\frac{1}{2} = N_R \times 3$$

or $\quad N_R = 1.339$ or $V = N_R \times 5.6 = 1.339 \times 5.6 = 7.5$

54. (a) **55. (a)** **56. (d)** **57. (d)**

58. (b): $5I^- + IO_3^- + \underset{\text{(from lime juice)}}{6H^+} \longrightarrow \underset{\text{violet}}{3I_2} + 3H_2O$

59. (b): $CH_2{=}CH_2 \xrightarrow{KMnO_4(1\%)} CH_2(OH)-CH_2(OH)$

$CH_2{=}CH_2 \xrightarrow{\text{Tollens' reagent}}$ No reaction

60. (a): Since KCl undergoes complete dissociation.

$KCl \longrightarrow K^+ + Cl^-$

One mole of KCl will give 2 mole particles and the value of 'i' will be equal to 2.

$\Delta T_f = i\, K_f\, m$

$K_f = 1.86$ K kg mol^{-1}, $\Delta T_f = 2$ K, $i = 2$

$\therefore \quad 2 = 2 \times 1.86 \times m$

or $\quad m = \frac{2}{2\times1.86} = 0.5376$ mol/kg

Grams of KCl = 0.5376 × 74.5 = 40.05 g per kg

$\therefore$ 40.05 g of KCl should be added to 1 kg of water.

61. (d) **62. (a)**

63. (a): $2Al_{(s)} + 6HCl_{(aq)} \longrightarrow 2Al^{3+}_{(aq)} + 6Cl^-_{(aq)} + 3H_{2(g)}$

At STP, 6 moles of HCl produce 3 moles of H_2

$= 3 \times 22.4$ L of H_2

$\therefore$ 1 mole of HCl produces $= \frac{3 \times 22.4}{6} = 11.2$ L of H_2

Again at STP, 2 moles of Al produces 3 moles of H_2

$= 3 \times 22.4$ L of H_2

$\therefore$ 1 mole of Al produces $= \frac{3\times22.4}{2}$

$= 33.6$ L of H_2 at STP.

64. (d)

65. (c): Cl_{17} : [Ne] $3s^2\, 3p^5$

Unpaired electron is in $3p$ orbital

$\therefore \quad n = 3,\ l = 1,\ m = -1, 0, 1$

66. (c): The sugar level in the blood of a diabetic person may suddenly fall, immediate intake of

glucose increases the blood sugar level almost instantaneously.

67. (d): $u_{rms} = \sqrt{\frac{3RT}{M}} = x \text{ m s}^{-1}$

$u_{rms} \propto \sqrt{T}$ as T = constant

$u_{rms} = x \text{ m s}^{-1}$

68. (c): $2KI + H_2SO_4 \longrightarrow K_2SO_4 + 2HI$

$2HI + H_2SO_4 \longrightarrow 2H_2O + SO_2 + I_2$

69. (d): $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

$\because$ The reaction consumes 2 moles of O_2 for 1 mole of CH_4 and produces 1 mole of CO_2.

$\therefore$ The reaction consumes 2 mL of O_2 for 1 mL of CH_4 and produces 1 mL of CO_2.

This means for the reaction to consume all the CH_4 present in the sample, we need

$$20 \text{ mL } CH_4 \times \frac{2 \text{ mL } O_2}{1 \text{ mL } CH_4} = 40 \text{ mL } O_2$$

Thus, CH_4 is limiting reagent.

Now, reaction will consume 20 mL of CH_4 and 40 mL of O_2 gas to produce

$$20 \text{ mL } CH_4 \times \frac{1 \text{ mL } O_2}{1 \text{ mL } CH_4} = 20 \text{ mL } CO_2$$

After the reaction is complete, O_2 left is

$(50 \text{ mL} - 40 \text{ mL})O_2 = 10 \text{ mL } O_2$

Now, the mixture of gas will contain

$= 10 \text{ mL } O_2 + 20 \text{ mL } CO_2 = 30 \text{ mL gas}$

70. (a)

71. (d): The *rms* velocity of a gas $= \sqrt{\frac{3P}{d}}$

$$\therefore \quad c_{rms} = \sqrt{\frac{3 \times 1.2 \times 10^5}{4}} = \sqrt{0.9 \times 10^5}$$

$$= \sqrt{9 \times 10^4} = 3 \times 10^2 = 300 \text{ m s}^{-1}$$

72. (a) **73. (d)**

74. (d): Volume of one molecule $= \frac{4}{3}\pi r^3$

$$= \frac{4}{3}\pi(1.54 \times 10^{-8})^3 \text{cm}^3 = 1.53 \times 10^{-23} \text{ cm}^3$$

Volume of all molecules in 1.65 g of Ar

$$= \frac{1.65}{40} \times N_A \times 1.53 \times 10^{-23} = 0.380 \text{ cm}^3$$

Volume of solid containing 1.65 g of Ar = 1 cm^3

$\therefore$ Empty space = 1 – 0.380 = 0.620

$\therefore$ Percentage of empty space = 62%

75. (c): In SO_4^{2-}, S is already in its highest oxidation state *i.e.*, +6 hence, can not be further oxidised.

76. (a): By white tin plating, bottom of the ship can be protected.

77. (c): Let mass of Ag in Zn = x g

Mass of Ag in Pb = $1 - x$ g

As partition coefficient of Ag in Zn and Pb is 300.

$$\therefore \quad 300 = \frac{\text{Concentration of Ag in molten Zn}}{\text{Concentration of Ag in molten Pb}}$$

$$300 = \frac{x/10}{1-x/100} = \frac{10x}{1-x} \Rightarrow 30(1-x) = x \text{ or } x = \frac{30}{31}$$

$$\Rightarrow \quad \text{Mass of Ag in Zn} = \frac{30}{31}$$

$$\% \text{ of Ag in Zn} = \frac{30}{31} \times 100 = 97\%$$

78. (a): $CH_3COOH + HCOOH \xrightarrow[570 \text{ K}]{MnO} CH_3CHO + CO_2 + H_2O$

79. (c): $Cu^{2+} + 2e^- \longrightarrow Cu$

$2 \times 96500 \text{ C} \equiv 1 \text{ mol Cu} = 1 \text{ mol } CuCl_2$

$$\therefore \quad 965 \text{ C} \equiv \frac{965}{2 \times 96500} = \frac{1}{200} \text{ mol } CuCl_2$$

$$\therefore \quad \text{Molarity of } CuCl_2 \text{ solution} = \frac{1}{200} \text{ mol L}^{-1}$$

$$= 0.005 \text{ M}$$

80. (a): $K_c = \frac{\left[\frac{C}{V}\right]^2}{\left[\frac{B}{V}\right]\left[\frac{A}{V}\right]^3} \Rightarrow 9 = \frac{\left[\frac{2}{V}\right]^2}{\left[\frac{2}{V}\right]\left[\frac{2}{V}\right]^3}$

$\Rightarrow \quad V = 6 \text{ L}$

ANSWER KEYS

81. (a)	**82. (d)**	**83. (d)**	**84. (d)**	**85. (a)**
86. (c)	**87. (a)**	**88. (b)**	**89. (a)**	**90. (a)**
91. (d)	**92. (b)**	**93. (d)**	**94. (c)**	**95. (a)**
96. (d)	**97. (c)**	**98. (a)**	**99. (b)**	**100. (b)**
101. (a)	**102. (c)**	**103. (c)**	**104. (b)**	**105. (c)**
106. (c)	**107. (c)**	**108. (c)**	**109. (d)**	**110. (a)**
111. (a)	**112. (a)**	**113. (a)**	**114. (b)**	**115. (b)**
116. (a)	**117. (b)**	**118. (c)**	**119. (d)**	**120. (c)**
121. (a)	**122. (b)**	**123. (d)**	**124. (a)**	**125. (a)**
126. (c)	**127. (d)**	**128. (a)**	**129. (b)**	**130. (d)**
131. (b)	**132. (b)**	**133. (c)**	**134. (b)**	**135. (b)**
136. (b)	**137. (d)**	**138. (c)**	**139. (d)**	**140. (b)**
141. (c)	**142. (a)**	**143. (a)**	**144. (b)**	**145. (c)**
146. (d)	**147. (b)**	**148. (d)**	**149. (d)**	**150. (b)**

JEE MAIN

Exam held on 8th April

SOLVED PAPER 2018

GOOD NEWS

We are happy to inform our readers that most of the questions asked in JEE Main 2018 Exam are similar to the problems given in **MTG JEE Books.**

GOOD NEWS

1. The ratio of mass percent of C and H of an organic compound ($C_XH_YO_Z$) is 6 : 1. If one molecule of the above compound ($C_XH_YO_Z$) contains half as much oxygen as required to burn one molecule of compound C_XH_Y completely to CO_2 and H_2O. The empirical formula of compound $C_XH_YO_Z$ is

(a) $C_3H_6O_3$ (b) C_2H_4O
(c) $C_3H_4O_2$ (d) $C_2H_4O_3$

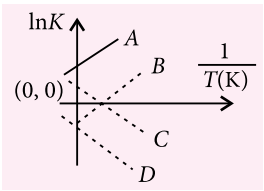
2. Which type of 'defect' has the presence of cations in the interstitial sites?

(a) Schottky defect (b) Vacancy defect
(c) Frenkel defect (d) Metal deficiency defect

3. According to molecular orbital theory, which of the following will not be a viable molecule?

(a) He_2^{2+} (b) He_2^{+} (c) H_2^{-} (d) H_2^{2-}

4. Which of the following lines correctly show the temperature dependence of equilibrium constant *K*, for an exothermic reaction?



(a) *A* and *B* (b) *B* and *C*
(c) *C* and *D* (d) *A* and *D*

5. The combustion of benzene (*l*) gives $CO_{2(g)}$ and $H_2O_{(l)}$. Given that heat of combustion of benzene at constant volume is –3263.9 kJ mol^{-1} at 25 °C; heat of combustion (in kJ mol^{-1}) of benzene at constant pressure will be (R = 8.314 J K^{-1} mol^{-1})

(a) 4152.6 (b) –452.43
(c) 3260 (d) –3267.6

6. For 1 molal aqueous solution of the following compounds, which one will show the highest freezing point?

(a) $[Co(H_2O)_6]Cl_3$ (b) $[Co(H_2O)_5Cl]Cl_2.H_2O$
(c) $[Co(H_2O)_4Cl_2]Cl.2H_2O$
(d) $[Co(H_2O)_3Cl_3].3H_2O$

7. An aqueous solution contains 0.10 M H_2S and 0.20 M HCl. If the equilibrium constants for the formation of HS^- from H_2S is 1.0×10^{-7} and that S^{2-} from HS^- ions is 1.2×10^{-13} then the concentration of S^{2-} ions in aqueous solution is

(a) 5×10^{-8} (b) 3×10^{-20}
(c) 6×10^{-21} (d) 5×10^{-19}

8. An aqueous solution contains an unknown concentration of Ba^{2+}. When 50 mL of a 1 M solution of Na_2SO_4 is added, $BaSO_4$ just begins to precipitate. The final volume is 500 mL. The solubility product of $BaSO_4$ is 1×10^{-10}. What is the original concentration of Ba^{2+} ?

(a) 5×10^{-9} M (b) 2×10^{-9} M
(c) 1.1×10^{-9} M (d) 1.0×10^{-10} M

9. At 518 °C, the rate of decomposition of a sample of gaseous acetaldehyde, initially at a pressure of 363 Torr, was 1.00 Torr s^{-1} when 5% had reacted and 0.5 Torr s^{-1} when 33% had reacted. The order of the reaction is

(a) 2 (b) 3 (c) 1 (d) 0

10. How long (approximate) should water be electrolysed by passing through 100 amperes current so that the oxygen released can completely burn 27.66 g of diborane?
(Atomic weight of B = 10.8 u)

(a) 6.4 hours (b) 0.8 hours
(c) 3.2 hours (d) 1.6 hours

11. The recommended concentration of fluoride ion in drinking water is upto 1 ppm as fluoride ion is required to make teeth enamel harder by converting $[3Ca_3(PO_4)_2{\cdot}Ca(OH)_2]$ to
(a) $[CaF_2]$ (b) $[3(CaF_2){\cdot}Ca(OH)_2]$
(c) $[3(Ca_3(PO_4)_2{\cdot}CaF_2]$ (d) $[3(Ca(OH)_2{\cdot}CaF_2]$

12. Which of the following compounds contain(s) no covalent bond(s)?
KCl, PH_3, O_2, B_2H_6, H_2SO_4
(a) KCl, B_2H_6, PH_3 (b) KCl, H_2SO_4
(c) KCl (d) KCl, B_2H_6

13. Which of the following are Lewis acids?
(a) PH_3 and BCl_3 (b) $AlCl_3$ and $SiCl_4$
(c) PH_3 and $SiCl_4$ (d) BCl_3 and $AlCl_3$

14. Total number of lone pairs of electrons in I_3^- ion is
(a) 3 (b) 6
(c) 9 (d) 12

15. Which of the following salts is the most basic in aqueous solution?
(a) $Al(CN)_3$ (b) CH_3COOK
(c) $FeCl_3$ (d) $Pb(CH_3COO)_2$

16. Hydrogen peroxide oxidises $[Fe(CN)_6]^{4-}$ to $[Fe(CN)_6]^{3-}$ in acidic medium but reduces $[Fe(CN)_6]^{3-}$ to $[Fe(CN)_6]^{4-}$ in alkaline medium. The other products formed are, respectively
(a) $(H_2O + O_2)$ and H_2O
(b) $(H_2O + O_2)$ and $(H_2O + OH^-)$
(c) H_2O and $(H_2O + O_2)$
(d) H_2O and $(H_2O + OH^-)$

17. The oxidation states of Cr in $[Cr(H_2O)_6]Cl_3$, $[Cr(C_6H_6)_2]$ and $K_2[Cr(CN)_2(O)_2(O_2)(NH_3)]$ respectively are
(a) +3, +4 and +6 (b) +3, +2 and +4
(c) +3, 0 and +6 (d) +3, 0 and +4

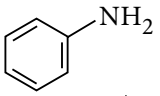
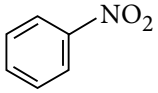
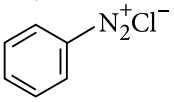
18. The compound that does not produce nitrogen gas by the thermal decomposition is
(a) $Ba(N_3)_2$ (b) $(NH_4)_2Cr_2O_7$
(c) NH_4NO_2 (d) $(NH_4)_2SO_4$

19. When metal '*M*' is treated with NaOH, a white gelatinous precipitate '*X*' is obtained, which is soluble in excess of NaOH. Compound '*X*' when heated strongly gives an oxide which is used in chromatography as an adsorbent. Then metal '*M*' is
(a) Zn (b) Ca
(c) Al (d) Fe

20. Consider the following reaction and statements :
$[Co(NH_3)_4Br_2]^+ + Br^- \longrightarrow [Co(NH_3)_3Br_3] + NH_3$
(I) Two isomers are produced if the reactant complex ion is a *cis*-isomer.
(II) Two isomers are produced if the reactant complex ion is a *trans*-isomer.
(III) Only one isomer is produced if the reactant complex ion is a *trans*-isomer.
(IV) Only one isomer is produced if the reactant complex ion is a *cis*-isomer.
The correct statements are
(a) (I) and (II) (b) (I) and (III)
(c) (III) and (IV) (d) (II) and (IV)

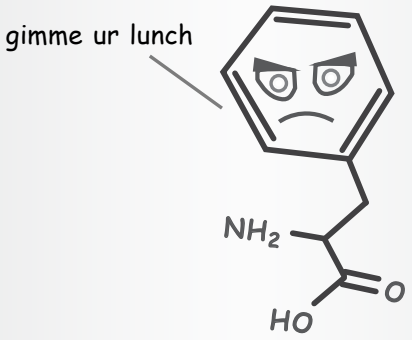
21. Glucose on prolonged heating with HI gives
(a) *n*-hexane (b) 1-hexene
(c) hexanoic acid (d) 6-iodohexanal.

22. The *trans*-alkene are formed by the reduction of alkynes with
(a) H_2, Pd/C, $BaSO_4$ (b) $NaBH_4$
(c) Na/liq. NH_3 (d) Sn/HCl

23. Which of the following compounds will be suitable for Kjeldahl's method for nitrogen estimation?
(a)  (b) 
(c)  (d) 

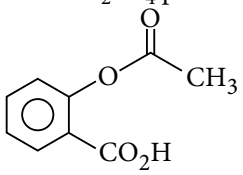
COMIC CAPSULE

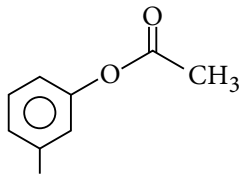
WHAT DO YOU CALL AN ACID WITH AN ATTITUDE?

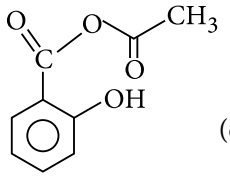


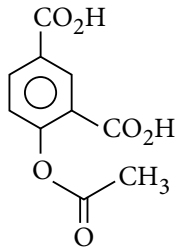
A-mean-oh acid

24. Phenol on treatment with CO_2 in the presence of NaOH followed by acidification produces compound *X* as the major product. *X* on treatment with $(CH_3CO)_2O$ in the presence of catalytic amount of H_2SO_4 produces

(a) 

(b) 

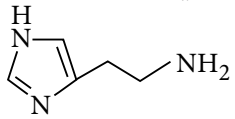
(c) 

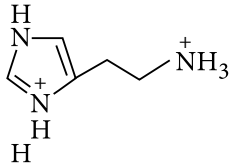
(d) 

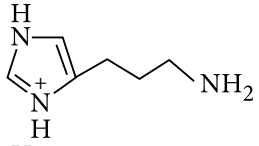
25. An alkali is titrated against an acid with methyl orange as indicator, which of the following is a correct combination ?

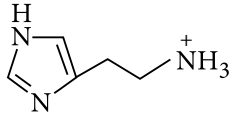
	Base	Acid	End point
(a)	Weak	Strong	Colourless to pink
(b)	Strong	Strong	Pinkish red to yellow
(c)	Weak	Strong	Yellow to pinkish red
(d)	Strong	Strong	Pink to colourless

26. The predominant form of histamine present in human blood is (pK_a, Histidine = 6.0)

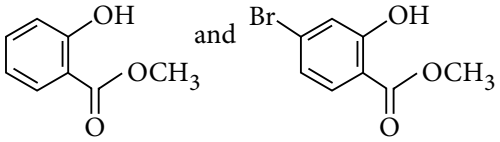
(a) 

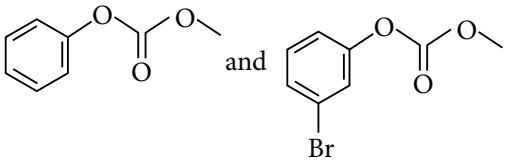
(b) 

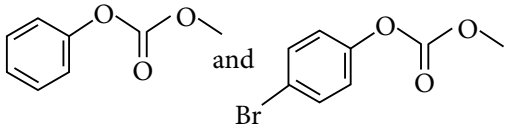
(c) 

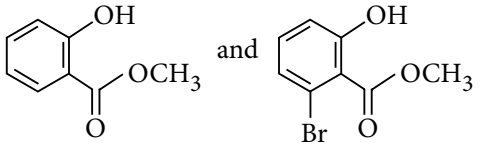
(d) 

27. Phenol reacts with methyl chloroformate in the presence of NaOH to form product *A*. *A* reacts with Br_2 to form product *B*. *A* and *B* are respectively

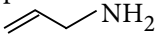
(a) 

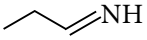
(b) 

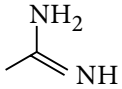
(c) 

(d) 

28. The increasing order of basicity of the following compounds is

(1) 

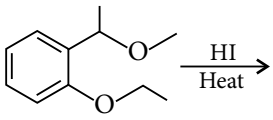
(2) 

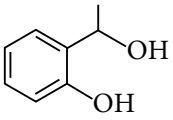
(3) 

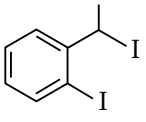
(4) 

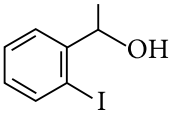
(a) (1) < (2) < (3) < (4)
(b) (2) < (1) < (3) < (4)
(c) (2) < (1) < (4) < (3)
(d) (4) < (2) < (1) < (3)

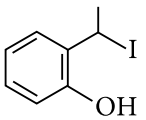
29. The major product formed in the following reaction is



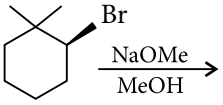
(a) 

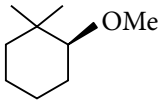
(b) 

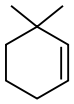
(c) 

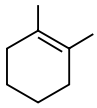
(d) 

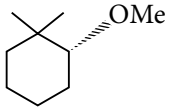
30. The major product of the following reaction is



(a) 

(b) 

(c) 

(d) 

SOLUTIONS

1. **(d) :** Mass of carbon in the given compound = $12X$

Mass of hydrogen in the given compound = Y

$$\frac{12X}{Y}=\frac{6}{1} \Rightarrow 2X=Y \qquad ...(i)$$

Combustion of C_XH_Y

$$C_XH_Y+\left(X+\frac{Y}{4}\right)O_2 \longrightarrow XCO_2+\frac{Y}{2}H_2O$$

Oxygen atoms required = $2\left(X+\frac{Y}{4}\right)$

As given, $\frac{1}{2}\times 2\left(X+\frac{Y}{4}\right)=Z$

Substituting the value of Y from eqn (i)

$$X+\frac{2X}{4}=Z \Rightarrow X+\frac{X}{2}=Z$$

$$\frac{3X}{2}=Z$$

Ratio of $X : Y : Z = X : 2X : \frac{3X}{2}$

i.e., 2 : 4 : 3

So, the formula of the compound is $C_2H_4O_3$

2. **(c) :** In Frenkel defect, an ion is displaced from its regular position to an interstitial position creating a vacancy or hole.

3. **(d) :** He_2^{2+} (2 electrons) $\Rightarrow \sigma 1s^2$

$$\text{B.O.}=\frac{2}{2}=1$$

He_2^{+} (3 electrons) $\Rightarrow \sigma 1s^2\ \sigma^* 1s^1$

$$\text{B.O.}=\frac{2-1}{2}=0.5$$

H_2^{-} (3 electrons) $\Rightarrow \sigma 1s^2\ \sigma^* 1s^1$

$$\text{B.O.}=\frac{2-1}{2}=0.5$$

H_2^{2-} (4 electrons) $\Rightarrow \sigma 1s^2\ \sigma^* 1s^2$

$$\text{B.O.}=\frac{2-2}{2}=0$$

Thus, H_2^{2-} cannot exist as it has zero bond order.

4. **(a) :** From thermodynamics,

$$\ln K=-\frac{\Delta H^\circ}{RT}+\frac{\Delta S^\circ}{R}$$

For exothermic reaction,

ΔH = –ve

$$\text{Slope} = -\frac{\Delta H^\circ}{R}=+\Delta$$

So, from graph, line should be *A* and *B*.

5. **(d) :** Combustion of benzene,

$$C_6H_{6(l)}+\frac{15}{2}O_{2(g)} \longrightarrow 6CO_{2(g)}+3H_2O_{(l)}$$

$\Delta H = \Delta U + \Delta n_g RT$

ΔU = –3263.9 kJ/mol

$$\Delta n_g = 6-\frac{15}{2} \Rightarrow -1.5$$

$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

T = 25 + 273 = 298 K

ΔH = –3263.9 – 1.5 × 8.314 × 298 × 10^{-3}

= –3263.9 –3.716 = – 3267.6 kJ/mol

6. **(d) :** $\Delta T_f = iK_f m$

m is same for all the solutions thus, $\Delta T_f \propto i$ (number of ions or molecules)

where, $\Delta T_f = T_f - T_i$

$[Co(H_2O)_6]Cl_3 \Rightarrow$ 4 ions (i = 4)

$[Co(H_2O)_5Cl]\ Cl_2{\cdot}H_2O \Rightarrow$ 3 ions (i = 3)

$[Co(H_2O)_4Cl_2]\ Cl{\cdot}2H_2O \Rightarrow$ 2 ions (i = 2)

$[Co(H_2O)_3Cl_3]{\cdot}3H_2O \Rightarrow$ No ion (i = 1)

Freezing point of solution increases, the value of i decreases. So, highest freezing point will be of $[Co(H_2O)_3Cl_3]{\cdot}3H_2O$ solution.

7. **(b) :** $H_2S \rightleftharpoons H^+ + HS^-$; $k_1 = 1.0 \times 10^{-7}$

$HS^- \rightleftharpoons H^+ + S^{2-}$; $k_2 = 1.2 \times 10^{-13}$

$H_2S \rightleftharpoons S^{2-} + 2H^+$

$K = k_1 \times k_2$

$= 1.0 \times 10^{-7} \times 1.2 \times 10^{-13} = 1.2 \times 10^{-20}$

$$K=\frac{[S^{2-}][H^+]^2}{[H_2S]}=1.2\times 10^{-20}$$

$$[S^{2-}]=\frac{1.2\times 10^{-20}\times[H_2S]}{[H^+]^2}$$

MPP CLASS XII ANSWER KEY

1.	(b)	**2.**	(c)	**3.**	(d)	**4.**	(a)	**5.**	(c)
6.	(a)	**7.**	(b)	**8.**	(a)	**9.**	(d)	**10.**	(b)
11.	(b)	**12.**	(c)	**13.**	(d)	**14.**	(b)	**15.**	(b)
16.	(b)	**17.**	(a)	**18.**	(a)	**19.**	(c)	**20.**	(b, c,d)
21.	(b, d)	**22.**	(a,b,c,d)			**23.**	(a,b,d)	**24.**	(4)
25.	(0)	**26.**	(1)	**27.**	(a)	**28.**	(c)	**29.**	(d)
30.	(b)								

$[H_2S] = 0.1$ M

$[HCl] = 0.2$ M

As HCl is stronger acid so, $[H^+] = 0.2$ M

$$[S^{2-}] = \frac{1.2\times10^{-20}\times0.1}{(0.2)^2} = 3\times10^{-20}\text{ M}$$

8. **(c) :** (Na_2SO_4) $(BaSO_4)$

$M_1V_1 = M_2V_2$

$1\text{ M}\times 50 = M_2\times 500$

$$M_2 = \frac{50}{500} = \frac{1}{10}$$

For just precipitation,

$Q_{sp} = k_{sp}$

$[Ba^{2+}]\,[SO_4^{2-}] = k_{sp}(BaSO_4)$

$$Ba^{2+}\times\frac{1}{10} = 10^{-10}$$

$Ba^{2+} = 10^{-9}$ M in 500 mL

Initially, $[Ba^{2+}]$ in original solution (450 mL)

$M_1\times 450 = 10^{-9}\times 500$

$$M_1 = \frac{500\times10^{-9}}{450} = 1.1\times10^{-9}\text{ M}$$

9. **(a) :** $r \propto (a-x)^n$ (n = order of reaction, $(a-x)$ = unreacted)

$$\frac{r_1}{r_2} = \left(\frac{a-x_1}{a-x_2}\right)^n$$

$$\frac{1}{0.5} = \left(\frac{100-5}{100-33}\right)^n = \left(\frac{95}{67}\right)^n$$

$2 = (1.41)^n = (\sqrt{2})^n$

i.e., $n = 2$

10. **(c) :** $\underset{27.66\text{ g}}{B_2H_6} + 3O_2 \longrightarrow \underset{96\text{ g}}{B_2O_3} + 3H_2O$

Thus, for combustion of 27.66 g of B_2H_6 oxygen required is 96 g.

According to Faraday's law of electrolysis,

$$w = ZIt = \frac{EIt}{96500}$$

$$96\text{ g} = \frac{8\times100\times t}{96500}$$

$$t = \frac{96\times96500}{8\times100} = 11{,}580\text{ s} \Rightarrow t = \frac{11580}{3600} = 3.2\text{ h}$$

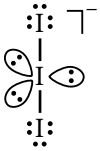
11. **(c) :** Tooth enamel is mostly hydroxy apatite. F^- converts this into the much harder fluorapatite.

$[3Ca_3(PO_4)_2\cdot Ca(OH)_2] \xrightarrow{F^-} [3Ca_3(PO_4)_2\cdot CaF_2]$

12. **(c) :** KCl is an ionic compound. While all other compounds contain covalent bond.

13. **(d) :** The compound which can accept a pair of electrons is known as Lewis acid. BCl_3 and $AlCl_3$ have vacant orbitals and their octet is not complete thus these can accept electron pairs and behave as Lewis acids.

14. **(c) :**



Total lone pairs = 9

15. **(b) :** $Al(CN)_3 + H_2O \rightleftharpoons \underset{\text{Weak base}}{Al(OH)_3} + \underset{\text{Weak acid}}{HCN}$

$CH_3COOK + H_2O \rightleftharpoons \underset{\text{Weak acid}}{CH_3COOH} + \underset{\text{Strong base}}{KOH}$

$FeCl_3 + H_2O \rightleftharpoons \underset{\text{Weak base}}{Fe(OH)_3} + \underset{\text{Strong acid}}{HCl}$

$Pb(CH_3COO)_2 \rightleftharpoons \underset{\text{Weak base}}{Pb(OH)_2} + \underset{\text{Weak acid}}{CH_3COOH}$

Hence, for the CH_3COOK, nature of solution is basic.

16. **(c) :** Oxidising action of H_2O_2 in acidic medium :

$2[Fe(CN)_6]^{4-} + H_2O_2 + 2H^+ \longrightarrow 2[Fe(CN)_6]^{3-} + 2H_2O$

Reducing action of H_2O_2 in alkaline medium :

$2[Fe(CN)_6]^{3-} + 2OH^- + H_2O_2 \longrightarrow 2[Fe(CN)_6]^{4-} + 2H_2O + O_2$

17. **(c) :** $[Cr(H_2O)_6]Cl_3 \Rightarrow x + 6\times0 + 3\times-1 = 0 \Rightarrow x = +3$

$[Cr(C_6H_6)_2] \Rightarrow x + 2\times0 \Rightarrow x = 0$

$K_2[Cr(CN)_2(O)_2(O_2)(NH_3)]$

$2\times(+1) + x + 2\times(-1) + 2\times(-2) + 2\times(-1) + 0 = 0$

$2 + x - 2 - 4 - 2 = 0 \Rightarrow x = +6$

18. **(d) :** $Ba(N_3)_2 \xrightarrow{\Delta} Ba + 3N_2$

$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3$

$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

$(NH_4)_2SO_4 \xrightarrow{\Delta} 2NH_3 + H_2SO_4$

19. **(c) :** Metal M could be Al as $Al(OH)_3$ is soluble in excess sodium hydroxide to form hydroxy aluminate ions. Al_2O_3 (oxide of metal M) is used as adsorbent in chromatography.

$$\underset{(M)}{Al} + NaOH \longrightarrow \underset{\substack{(X)\\\text{White ppt}}}{Al(OH)_3\downarrow} + 3Na^+$$

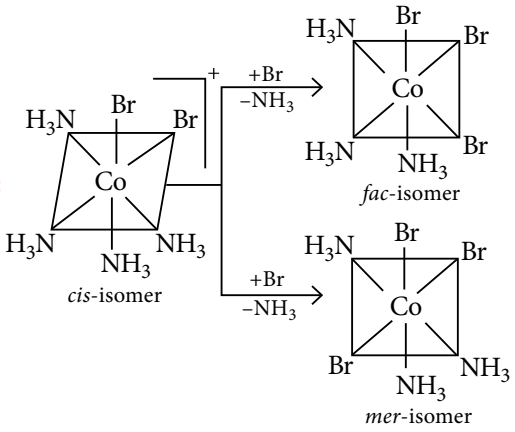
$$\downarrow \text{NaOH (excess)}$$

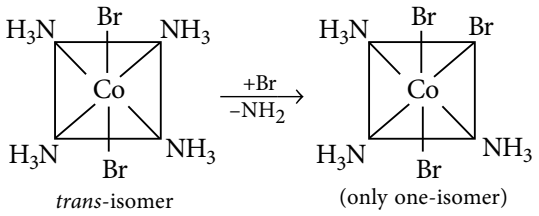
$$Na[Al(OH)_4]$$

Sod. tetrahydroxoaluminate (III)

(Soluble)

20. (b) :



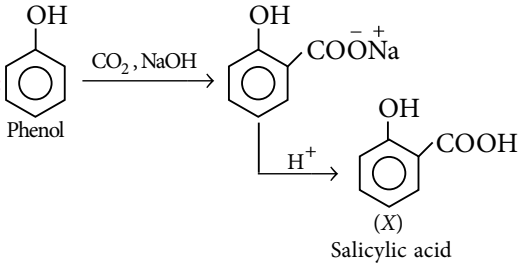


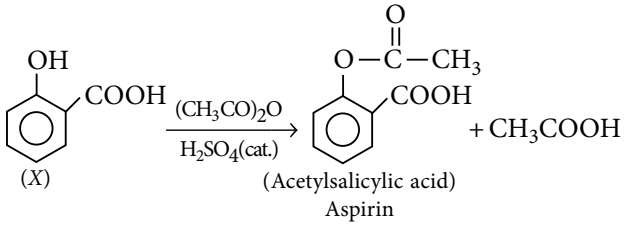
21. (a)

22. (c) : $R-C\equiv C-R \xrightarrow[\text{Birch reduction}]{\text{Na/liq.NH}_3}$ *trans*-Alkene
(Alkyne)

23. (b) : Kjeldahl's method is very convenient method. This method is suitable for estimating nitrogen in those organic compounds in which nitrogen is linked to carbon and hydrogen. This method is not used in case of nitro, azo and azoxy compounds and for the compound containing nitrogen in the ring (*e.g.*, pyridine, quinoline, isoquinoline, etc.)

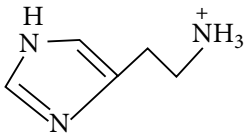
24. (a) :



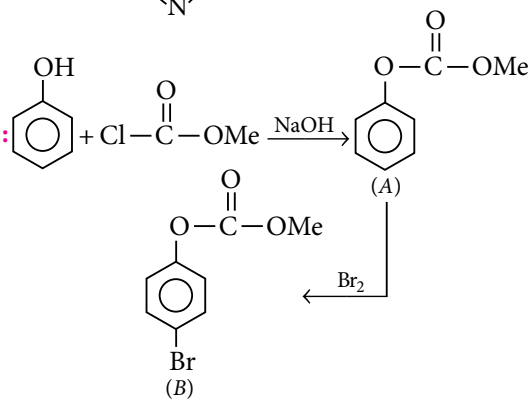


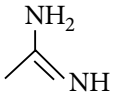
25. (c) : Methyl orange shows yellow colour in basic medium and red colour in acidic medium.

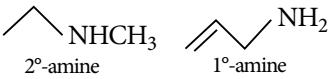
26. (d) : Histamine has two basic centres namely the aliphatic amino group and nitrogen of imidazole ring that does not already have a proton. In human blood, the aliphatic amino group (pK_a around 9.4) will be protonated whereas the second nitrogen of imidazole ring (pK_a = 5.8) will not be protonated.

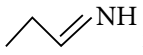


27. (c) :

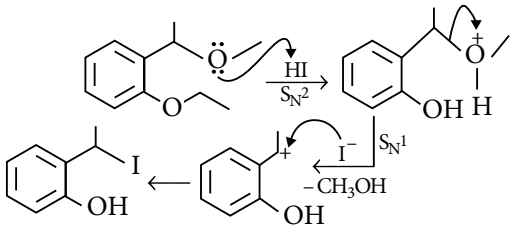


28. (c) :  strongest base as electrons of one nitrogen can easily donate due to –ve charge.
Now, out of 1 and 4, 4 is stronger as

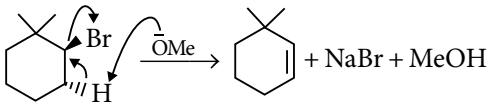


 is least basic as it involve sp^2 hybridised N-atoms.
So, the increasing order of basicity is
2 < 1 < 4 < 3

29. (d) :



30. (b) : NaOMe is acting as a base thus it will cause abstraction of H^+ ion. Thus, *E*2 elimination will take place.



MPP MONTHLY Practice Paper

Class XI

This specially designed column enables students to self analyse their extent of understanding of complete syllabus. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120 **Time Taken : 60 Min.**

NEET / AIIMS

Only One Option Correct Type

1. When water is dropped over sodium peroxide, the colourless gas produced is
(a) dinitrogen (b) dioxygen
(c) dihydrogen (d) hydrogen peroxide.

2. Among the following ionisations, which one will have the maximum value of ionisation energy?
(a) $Be \rightarrow Be^+$ (b) $Be^+ \rightarrow Be^{2+}$
(c) $Sr \rightarrow Sr^+$ (d) $Sr^+ \rightarrow Sr^{2+}$

3. The concentration of oxalic acid solution is x mol L^{-1}. 40 mL of this solution reacts with 16 mL of 0.05 M acidified $KMnO_4$ solution. Assuming that oxalic acid dissociates completely, pH of the given oxalic acid solution is
(a) 1.0 (b) 1.3 (c) 1.699 (d) 2.0

4. $2Al_{(s)} + Fe_2O_{3(s)} \rightarrow Al_2O_{3(s)} + 2Fe_{(s)}; \Delta H° = -851.4 kJ mol^{-1}$. How much heat is released when 72.0 g of Al reacts with excess Fe_2O_3?
(a) 1136 kJ mol^{-1} (b) 1278 kJ mol^{-1}
(c) 2.28×10^3 kJ mol^{-1} (d) 2.54×10^3 kJ mol^{-1}

5. Product '*P*' of the given reaction,

$CH_3-CH=CH-CH_3 \xrightarrow[-78\ °C]{O_3/CH_2Cl_2} P$, will be

(a) CH_3-CHO (b) CH_3-COOH

(c) $CH_3-\underset{\underset{OH}{|}}{CH}-\underset{\underset{OH}{|}}{CH}-CH_3$

(d) $CH_3-\underset{\underset{O-O}{|}}{\overset{\overset{O}{/\backslash}}{CH}}\ CH-CH_3$

6. A mineral containing iron (II) sulphide but no other sulphide is treated with excess of hydrochloric acid to produce hydrogen sulphide gas. If 3.15 g sample of mineral yielded 448 mL of hydrogen sulphide gas at 0 °C and 760 mm pressure, the mass percentage of iron (II) sulphide in the sample is
(a) 20.6 (b) 35.2
(c) 55.8 (d) 72.4

7. The normality and volume strength of a solution made by mixing 1.0 L each of 5.6 volume and 11.2 volume H_2O_2 solution are
(a) 1 N, 5.6 vol (b) 1.5 N, 5.6 vol
(c) 1.5 N, 8.4 vol (d) 1 N, 8.4 vol

8. Which of the following is not true?
(a) SH_6 and $BiCl_5$ do not exist.
(b) There are two $p\pi$–$d\pi$ bonds in SO_3^{2-}.
(c) SeF_4 and CH_4 are tetrahedral species.
(d) I_3^- is a linear molecule with sp^3d-hybridisation.

9. Fluorosis, a bone disease, is caused by the presence of
(a) carbon monoxide in air
(b) SO_2 in air
(c) pesticides in water
(d) fluoride in water.

10. Considering that NaOH neither oxidises nor reduces CrO_2Cl_2, which of the following species will be formed when CrO_2Cl_2 is dissolved in NaOH solution?
(a) CrO_4^{2-} (b) Cl_2O
(c) ClO_2 (d) $Cr(OH)_3$

11. A pre-weighed vessel was filled with oxygen at N.T.P. and weighed. It was then evacuated, filled with SO_2 at the same temperature and pressure, and again weighed. The weight of oxygen will be
(a) the same as that of SO_2
(b) $\frac{1}{2}$ that of SO_2
(c) twice that of SO_2
(d) one fourth that of SO_2.

12. Which of the following sets of quantum numbers is correct for a 4*d*-electron?
(a) $4, 3, 2, +\frac{1}{2}$ (b) 4, 2, 1, 0
(c) $4, 2, -2, +\frac{1}{2}$ (d) $4, 2, 3, -\frac{1}{2}$

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** A spectral line will be seen for a $2p_x \rightarrow 2p_y$ transition.
Reason : Energy is released in the form of wave of light when the electron drops from the $2p_x$ to the $2p_y$ orbital.

14. **Assertion :** Sodium reacts with oxygen to form Na_2O_2 whereas potassium reacts with oxygen to form KO_2.
Reason : Potassium is more reactive than sodium.

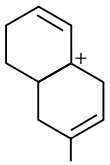
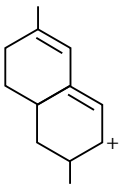
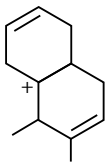
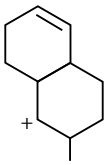
15. **Assertion :** An endothermic reaction gives a better yield of products at higher temperature.
Reason : The equilibrium constant of an endothermic reaction increases with increasing temperature.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. Which of the following are isoelectronic and isostructural?
NO_3^-, CO_3^{2-}, ClO_3^-, SO_3
(a) CO_3^{2-}, ClO_3^- (b) CO_3^{2-}, NO_3^-
(c) SO_3, ClO_3^- (d) SO_3, NO_3^-

17. Rank the following carbocations in increasing order of stability :

(i) 
(ii) 
(iii) 
(iv) 

(a) iv < iii < i < ii (b) iv < i < iii < ii
(c) iii < ii < i < iv (d) i < iii < ii < iv

18. Na_2SiO_3 is a polymer. How many O-atoms are shared by each SiO_4^{4-} tetrahedron with other SiO_4^{4-} tetrahedra?
(a) 0 (b) 1 (c) 2 (d) 3

19. The pK_a of acetyl salicylic acid (aspirin) is 3.5. The pH of gastric juice in the human stomach is about 2 to 3 and the pH in the small intestine is 8. Aspirin will be
(a) unionised in the small intestine and in the stomach
(b) completely ionised in the small intestine and in the stomach
(c) ionised in the stomach and almost unionised in the small intestine
(d) ionised in the small intestine and almost unionised in the stomach.

More than One Options Correct Type

20. The $\Delta_i H$ and $\Delta_{eg} H$ of an element *A* are + 450 kJ mol^{-1} and –100 kJ mol^{-1}. Which of the following options are true with respect to A^+ and A^- ions?

(a) $\Delta_{eg}H$ of $A^+ = -450$ kJ mol^{-1}
(b) Δ_iH of $A^- = -100$ kJ mol^{-1}
(c) $\Delta_{eg}H$ of $A^+ = +350$ kJ mol^{-1}
(d) Δ_iH of $A^- = +550$ kJ mol^{-1}

21. Which of the following reactions involve increase in entropy?
(a) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$
(b) $2HI_{(g)} \rightarrow H_{2(g)} + I_{2(g)}$
(c) $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(l)}$
(d) S (Rhombic) + $O_{2(g)} \rightarrow SO_{2(g)}$

22. Which of the following statements are false?
(a) $BeCl_2$ exists as dimer in the vapour state and polymeric in the solid state.
(b) Calcium hydride is called hydrolith.
(c) The oxides of Be and Ca are amphoteric.
(d) Bicarbonates of Na and Sr are insoluble in water.

23. Which of the following reactions are correctly represented?
(a) $R-CH=CH_2 + HCl \rightarrow R-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_3$
(b) $R-CH=CH_2 + HI \xrightarrow{\text{Peroxide}} R-CH_2-CH_2-I$
(c) $R-CH=CH_2 + HBr \xrightarrow{\text{Peroxide}} R-CH_2-CH_2-Br$
(d) $R-CH=CH_2 + HI \xrightarrow{\text{Peroxide}} R-\underset{\displaystyle I}{\underset{|}{CH}}-CH_3$

Integer Answer Type

24. An alkaloid contains 17.28% of nitrogen and its molecular mass is 162. The number of nitrogen atoms present in one molecule of the alkaloid is

25. The number of stereoisomers obtained by bromination of *trans*-2-butene is

26. A diatomic molecule has a dipole moment of 1.2 D. If the bond distance is 1 Å, $1/x$ of an electronic charge exists on each atom. The value of x is

Comprehension Type

Rocks, clays and soils are made up of silicates of aluminium, iron, magnesium and other metals. All silicates are made up of SiO_4 tetrahedral units in which Si is sp^3-hybridised and is surrounded by four oxygen atoms. The SiO_4 tetrahedra can be linked together in

TOP PLACES TO STUDY IN INDIA

As per NIRF rankings released on 3rd April 2018

OVERALL TOPPERS		TOP COLLEGES		TOP UNIVERSITIES	
1	IISc, Bangalore	1	Miranda House, Delhi	1	IISc, Bangalore
2	IIT, Madras	2	St Stephen's, Delhi	2	JNU, Delhi
3	IIT, Bombay	3	Bishop Heber, Tiruchirappalli	3	BHU, Varanasi
4	IIT, Delhi	4	Hindu College, Delhi	4	Anna University, Chennai
5	IIT, Kharagpur	5	Presidency College, Chennai	5	University of Hyderabad, Hyderabad
6	JNU, Delhi	**MEDICAL**		**ENGINEERING**	**MANAGEMENT**
7	IIT, Kanpur	1	AIIMS, New Delhi	1 IIT, Madras	1 IIM, Ahmedabad
8	IIT, Roorkee	2	PGIMER, Chandigarh	2 IIT, Bombay	2 IIM, Bangalore
9	BHU, Varanasi	3	Christian Medical College, Vellore	3 IIT, Delhi	3 IIM, Calcutta
10	Anna University, Chennai	4	Kasturba Medical College, Manipal	4 IIT, Kharagpur	4 IIM, Lucknow
		5	King George's Medical University, Lucknow	5 IIT, Kanpur	5 IIT, Bombay

LAW				
1. National Law School of India University, Bangalore	**2.** National Law University, Delhi	**3.** Nalsar University of Law, Hyderabad	**4.** Indian Institute of Technology, Kharagpur	**5.** National Law University, Jodhpur

several different ways. Depending on the number of corners of the SiO_4 tetrahedra shared, various kinds of silicates are formed.

27. Quartz watches contain
(a) a crystal of quartz as an essential component
(b) a coating of quartz on the outer body
(c) hands made up of quartz
(d) silica coated on the numbers.

28. Which of the following is not a crystalline form of silica?
(a) Quartz (b) Tridymite
(c) Cristobalite (d) Kieselguhr

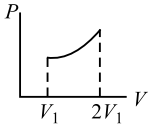
Matrix Match Type

29. Match the List I with List II and choose the correct answer using the codes given below the lists.

	List I (Conversion)	List II (Reagents)
P.	$(CH_3)_3C-CH=CH_2 \rightarrow (CH_3)_2C(OH)-CH(CH_3)_2$	(i) $B_2H_6/H_2O_2/OH^-$
Q.	$(CH_3)_3C-CH=CH_2 \rightarrow (CH_3)_3C-CH(OH)-CH_3$	(ii) $H_2O/H^+/MnO_2$
R.	$C_6H_5-CH=CH_2 \rightarrow C_6H_5-CHO$	(iii) $Hg(OAc)_2/H_2O/NaBH_4$
S.	$C_6H_5-C\equiv CH \rightarrow C_6H_5-CH_2-CHO$	(iv) H_2O/H^+

	P	Q	R	S
(a)	(i)	(ii)	(iii)	(iv)
(b)	(iv)	(iii)	(ii)	(i)
(c)	(iv)	(ii)	(i)	(iii)
(d)	(i)	(iv)	(ii)	(iii)

30. Match List I containing a list of processes involving expansion of an ideal gas with List II describing the thermodynamic change during corresponding process and choose the correct answer using the codes given below the lists.

	List I	List II
P.	An insulated container has two chambers separated by a valve. Chamber I contains an ideal gas and the chamber II has vacuum. The valve is opened.	(i) The temperature of the gas decreases.
Q.	An ideal monoatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^2}$; where, V is the volume of the gas.	(ii) The temperature of the gas remains constant.
R.	An ideal monoatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^{4/3}}$; where, V is its volume.	(iii) The temperature of the gas increases.
S.	An ideal monoatomic gas expands such that its pressure P and volume V follows the behaviour shown in the graph : 	(iv) The gas loses heat. (v) The gas gains heat.

	P	Q	R	S
(a)	(i, iii)	(ii)	(iv)	(i, ii)
(b)	(ii)	(i, iv)	(i, iii)	(ii, iv)
(c)	(ii)	(i, v)	(i, v)	(iii, v)
(d)	(iii, iv)	(i, ii)	(iv)	(i)

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SELF CHECK

No. of questions attempted .....
No. of questions correct .....
Marks scored in percentage .....

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

MPP MONTHLY Practice Paper

This specially designed column enables students to self analyse their extent of understanding of complete syllabus. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120 **Time Taken : 60 Min.**

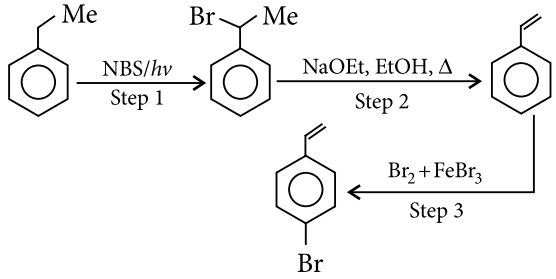
NEET / AIIMS

Only One Option Correct Type

1. In a mixture of PbS, ZnS and FeS, each component is separated from other by using the reagents in the following sequence in froth floatation process

(a) potassium ethyl xanthate, KCN
(b) potassium ethyl xanthate, KCN, NaOH, $CuSO_4$, acid
(c) KCN, $CuSO_4$, acid
(d) none of these.

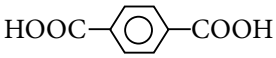
2. In the following reaction, which of the following steps is wrong?



(a) Step 1 (b) Step 2
(c) Step 3 (d) None of these

3. Which one of the following sets of monomers forms the biodegradable polymer?

(a) $HO-CH_2-CH_2-OH$ and



(b)  $-CH=CH_2$ and $CH_2=CH-CH=CH_2$

(c) $CH_2=CH-CN$ and $CH_2=CH-CH=CH_2$

(d) H_2N-CH_2-COOH and $H_2N-(CH_2)_5-COOH$

4. The resistance of 0.01 N solution of an electrolyte was found to be 210 ohm at 298 K, using a conductivity cell of cell constant 0.66 cm^{-1}. The equivalent conductance of solution is

(a) 314.28 mho cm^2 eq^{-1}
(b) 3.14 mho cm^2 eq^{-1}
(c) 314.28 mho^{-1} cm^2eq^{-1}
(d) 3.14 mho^{-1} cm^2eq^{-1}

5. Hydrolysis of one mole of peroxodisulphuric acid produces

(a) two moles of sulphuric acid
(b) two moles of peroxomonosulphuric acid
(c) one mole of sulphuric acid and one mole of peroxomonosulphuric acid
(d) one mole of sulphuric acid, one mole of peroxomonosulphuric acid and one mole of hydrogen peroxide.

6. A compound has molecular formula, $C_6H_{12}O$. It does not reduce Tollens' or Fehling's reagent, but gives a crystalline derivative with 2, 4-dinitrophenyl hydrazine. With alkali and I_2, it gives yellow solid with

Quotable Quote

We have all heard of the puzzle given to Archimedes... His finding that the crown was of gold was a discovery, but he invented the method of determining the density of solids. Indeed, discoverers must generally be inventors, though inventors are not necessarily discoverers.

Sir William Ramsay

a medicinal odour. Clemmensen reduction converts it to 2-methylpentane. The structural formula of the compound is most likely to be

(a) $CH_3—COCH_2—CH—(CH_3)_2$
(b) $CH_3—CH_2—CO—CH—(CH_3)_2$
(c) $CH_3CH_2CH_2—CO—CH_2CH_3$
(d) $(CH_3)_2—CH—CO—CH—(CH_3)_2$

7. An organic compound with the molecular formula C_3H_5N, on acidic hydrolysis forms an acid which reduces Fehling's solution. The compound can be

(a) ethanenitrile (b) *iso*-cyanoethane
(c) ethoxyethane (d) propanenitrile.

8. The edge length of face centred cubic unit cell is 508 pm. If the radius of the cation is 110 pm, the radius of the anion is

(a) 144 pm (b) 288 pm
(c) 628 pm (d) 398 pm.

9. Absolute alcohol (100% ethanol) are prepared from rectified spirit (95% ethanol) by mixing a suitable amount of _____ and subjected to fractional distillation (azeotropic distillation).

(a) toluene (b) *o*-xylene
(c) methanol (d) benzene

10. When white light is passed through a colloidal solution containing fine suspended particles of gold, then the scattered light seen in a direction different from that of the incident light is

(a) yellow coloured (b) blue coloured
(c) green coloured (d) red coloured.

11. An element of 3*d*-transition series shows two oxidation states *x* and *y* that differ by two units then

(a) compounds in oxidation state *x* are ionic if $x > y$
(b) compounds in oxidation state *x* are ionic if $x < y$
(c) oxidation state has no relation to the nature of bond
(d) compounds in oxidation state *y* are covalent if $y > x$.

12. The reaction, $X \longrightarrow$ product, follows first order kinetics. In 40 minutes, the concentration of *X* changes from 0.1 M to 0.025 M, then rate of reaction, when concentration of *X* is 0.01 M, is

(a) 1.73×10^{-4} M/min
(b) 3.47×10^{-5} M/min
(c) 3.47×10^{-4} M/min
(d) 1.73×10^{-5} M/min.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** The $[Ni(en)_3]Cl_2$ (*en* = ethylenediamine) has lower stability than $[Ni(NH_3)_6]Cl_2$.
Reason : In $[Ni(en)_3]Cl_2$ the geometry of Ni is trigonal bipyramidal.

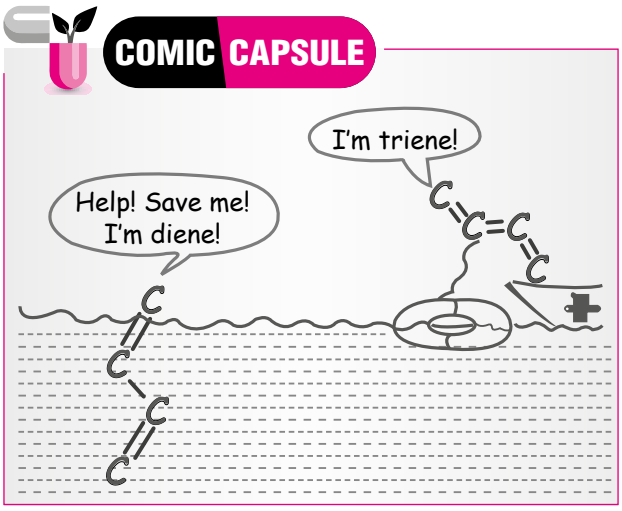
14. **Assertion :** Glycine exists as zwitter ion but *o*-and *p*-amino benzoic acid do not.
Reason : Due to the presence of $–NH_2$ and –COOH groups within the same molecule, they neutralise each other and hence α-amino acids exist as dipolar ions or zwitter ions.

15. **Assertion :** Hydrometallurgy involves dissolving the ore in a suitable reagent followed by precipitation of the metal by a more electropositive metal.
Reason : Copper is extracted by hydrometallurgy.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. A 3.42% (mass/vol.) solution of cane sugar is isotonic with a 5.96% (mass/vol.) solution of raffinose. The molecular mass of raffinose is

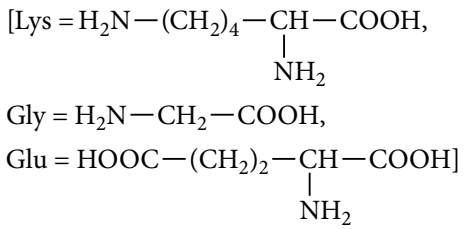


(a) 59.6 (b) 596
(c) 5.96 (d) 5960

17. Under the same reaction conditions, initial concentration of 1.386 mol dm^{-3} of a substance becomes half in 40 seconds and 20 seconds through first order and zero order kinetics, respectively. Ratio (k_1/k_0) of the rate constant for first order (k_1) and zero order (k_0) of the reactions is
(a) 0.5 mol^{-1} dm^3 (b) 1.0 mol dm^{-3}
(c) 1.5 mol dm^{-3} (d) 2.0 mol^{-1} dm^3

18. A coordination complex of type MX_2Y_2 (M-metal ion; X, Y-monodentate ligands), can have either a tetrahedral or a square planar geometry. The maximum number of possible isomers in these two cases are respectively
(a) 1 and 2 (b) 2 and 1
(c) 1 and 3 (d) 3 and 2

19. Predict the direction of migration of following tripeptide at pH 6.
Lys – Gly – Glu;



(a) Cathodal (b) Anodal
(c) Stationary (d) Unpredictable

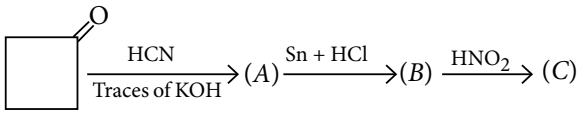
More than One Options Correct Type

20. When O_2 is adsorbed on a metallic surface, electron transfer occurs from the metal to O_2. The true statement(s) regarding this adsorption are
(a) O_2 is physisorbed
(b) heat is released
(c) occupancy of π^*_{2p} of O_2 is increased
(d) bond length of O_2 is increased.

21. Aryl halides are less reactive towards nucleophilic substitution reaction as compared to alkyl halides due to
(a) the formation of less stable carbonium ion
(b) resonance stabilisation
(c) the inductive effect
(d) sp^2-hybridised carbon attached to the halogen.

22. Which of the following statements are correct?
(a) An acidified solution of potassium permanganate oxidizes nitric oxide to nitrate ion.
(b) The reaction, $2HNO_3 + NO \rightarrow 3NO_2 + H_2O$ completely moves in the forward direction with conc. HNO_3.
(c) The action of conc. HNO_3 on metals produces NO_2 because the equilibrium of the reaction, $2HNO_3 + NO \rightleftharpoons 3NO_2 + H_2O$ lies far towards the right.
(d) The action of dilute HNO_3 on metals produces NO because of the reaction,
$HNO_3 + NO \rightleftharpoons 3NO_2 + H_2O$

23. Which of the following statements are correct about the reaction sequence given below?



(a) In the formation of (C) from (B), ring expansion takes place.
(b) The product (C) is cyclopentanone.
(c) The product (C) is α, β-unsaturated cyclopentanone.
(d) Conversion of (A) to (B) can also be carried out with $LiAlH_4$.

Integer Answer Type

24. A metal 'X' crystallises in a unit cell in which the radius of atom (r) is related to edge of unit cell (a) as $r = 0.3535\ a$. The total number of atoms present per unit cell is

EXAM CORNER 2018

Exam	Date
NEET	6th May
MHT CET	10th May
COMEDK (Engg.)	13th May
AMU (Engg.)	13th May
BITSAT	16th to 31st May
JEE Advanced	20th May
AIIMS	26th & 27th May
JIPMER	3rd June

25. How many of the following substances are more acidic than phenol?
o-Cresol, *m*-cresol, *p*-cresol, water, methyl alcohol, ethyl alcohol, 2,4-dimethylphenol, *p*-ethylphenol, dimethylcarbinol

26. An alloy of Pb-Ag weighing 1.08 g was dissolved in dilute HNO_3 and the volume made to 100 mL. A silver electrode was dipped in the solution and EMF of the cell set up was
$Pt_{(s)}, H_{2(g)}|H^+ (1\ M)||\ Ag^+_{(aq)}|Ag_{(s)}$
0.62 V. The percentage of Ag in the alloy is
[E°_{cell} = 0.80 V, 2.303 RT/F = 0.06 at 25 °C]

Comprehension Type

Synthetic tranquilizers are mostly barbituric acid derivatives while, other tranquilizers are not barbituric acid derivatives. Opium alkaloids such as morphine and codeine are powerful analgesics (reduce pain). Drugs which are used to cure diseases caused by microbes are called antimicrobials. These may be either sulphadrugs or they may be antibiotics. Antibiotics which inhibit the growth of microbes are called bacteriostatic while others which kill the microbes are called bactericidal antibiotics.

27. Among the following the narcotic analgesic is
(a) heroin
(b) ibuprofen
(c) naproxen
(d) aspirin.

28. The bactericidal and bacteriostatic antibiotics respectively are
(a) penicillin, ofloxacin
(b) erythromycin, tetracycline
(c) penicillin, chloramphenicol
(d) tetracycline and penicillin.

Matrix Match Type

29. Match the List I with List II and select the correct answer using the codes given below the lists :

	List I (Equimolar solute)	List II (Osmotic pressure ratio)
P.	Glucose, NaCl, $MgCl_2$	1. 2 : 3: 3
Q.	NaCl, $MgCl_2$, K_2SO_4	2. 1 : 0.8 : 1
R.	$Al_2(SO_4)_3$, Na_3PO_4, $K_4[Fe(CN)_6]$	3. 1 : 2 : 3
S.	Urea, glucose, fructose	4. 1 : 1 : 1

	P	Q	R	S
(a)	1	2	3	4
(b)	2	3	1	4
(c)	2	1	4	3
(d)	3	1	2	4

30. Match the List I with List II and select the correct answer using the codes given below the lists :

	List I (Compound/element)	List II (Uses)
P.	Individual lanthanoid oxide	1. Production of alloys
Q.	Lanthanoid	2. Television screen
R.	Mischmetal	3. Petroleum cracking
S.	Mixed oxides of lanthanoids	4. Produce bullets, shell and lighter flint.

	P	Q	R	S
(a)	1	2	3	4
(b)	2	1	4	3
(c)	4	3	1	2
(d)	3	2	4	1

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted .....
No. of questions correct .....
Marks scored in percentage .....

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

Contd. from P. No. 30

1. In all above sequence C-terminal is alanine.
2. Glycine is optically inactive amino acid, hence it should not be N-terminal so, only above combination are possible.

13. (b) : $Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$

Cr^{3+} gives green ppt. of $Cr(OH)_3$ in NH_4OH in presence of NH_4Cl.

14. (c) : Co^{2+} gives black ppt. of CoS with H_2S in presence of NH_4OH.

15. (b) : The ion could be As^{3+} as it belongs to *p*-block and As_2O_3 has the uses described.

As^{3+} gives yellow ppt. of As_2S_3 with H_2S in presence of HCl.

$$As_2S_5 + 10HNO_3 \longrightarrow \underset{\text{Arsenic acid}}{2H_3AsO_4} + 10NO_2 + 2H_2O + 5S$$

$$H_3AsO_4 + 12(NH_4)_2MoO_4 + 21HNO_3 \longrightarrow \underset{\text{Yellow ppt.}}{(NH_4)_3AsO_4.12MoO_3} + 21NH_4NO_3 + 12H_2O$$

16. (c) : The aim is to find Z by using the formula

$$\rho = \frac{Z \times M}{a^3 \times N_0}$$

$$\therefore \quad Z = \frac{\rho \times a^3 \times N_0}{M} = \frac{0.53 \times (3.5 \times 10^{-8})^3 \times (6.023 \times 10^{23})}{6.94\ \text{g}}$$

$$= 1.97 \simeq 2$$

$Z = 2$ means *bcc* structure thus, $r = \frac{\sqrt{3}a}{4}$ and Packing efficiency is 68%.

17. (a) : Diameter of greatest sphere = 117.08 pm

Thus, radius of greatest sphere (r) = $\frac{117.08}{2}$

= 58.54 pm

As the octahedral void is bigger in size then tetrahedral. Thus, given sphere is octahedral and for octahedral void (r) = 0.414 R

$$58.54 = 0.414\ R$$

$$R = \frac{58.54}{0.414} = 141.4\ \text{pm}$$

Radius of atom (R) = 141.4 pm

Edge length = 400 pm (given)

This shows the relation (R) = $\frac{a}{2\sqrt{2}}$

This relation is correct for *fcc*. Number of atoms per unit cell is 4 and packing efficiency is 74% in *fcc*. Thus, the correct combination is (IV) (ii) (S).

18. (c) : The given structure represents simple cubic cell and correct combination is (III) (i) (Q).

PAPER - II

1. (b): E of light absorbed in one photon = $\frac{hc}{\lambda_{absorbed}}$

Let n_1 photons are absorbed, therefore,

Total energy absorbed = $\frac{n_1 hc}{\lambda_{absorbed}}$

Now, E of light re-emitted out in one photon

$$= \frac{hc}{\lambda_{emitted}}$$

Let n_2 photons are re-emitted then,

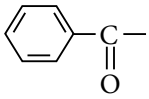
Total energy re-emitted out = $n_2 \times \frac{hc}{\lambda_{emitted}}$

As given, $E_{absorbed} \times \frac{47}{100} = E_{re\text{-}emitted}$

$$\frac{hc}{\lambda_{absorbed}} \times n_1 \times \frac{47}{100} = n_2 \times \frac{hc}{\lambda_{emitted}}$$

$$\therefore \quad \frac{n_2}{n_1} = \frac{47}{100} \times \frac{\lambda_{emitted}}{\lambda_{absorbed}} = \frac{47}{100} \times \frac{5080}{4530}$$

$$\therefore \quad \frac{n_2}{n_1} = 0.527$$

2. (b): $-I$ effect at α carbon (carbon attached to leaving group) will be exerted by  hence (*S*) will be most reactive.

3. (c) : Molecular mass of CaC_2 = 40 + 24 = 64

64 kg of CaC_2 gives = 28 kg of ethene

20 kg of CaC_2 will give = $\frac{28}{64} \times 20 = 8.75$ kg

≈ 9 kg polythene

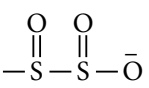
4. (b): $FeCr_2O_4 \xrightarrow[\Delta]{NaOH/air} Na_2CrO_4 \xrightarrow{C,\ \Delta} Cr_2O_3 \xrightarrow{Al,\ \Delta} Cr$

5. (a): For precipitation, ionic product > $K_{sp.}$

Ionic product = $[Ag^+]\ [Cl^-]$

$$= \frac{10^{-4}}{2} \times \frac{10^{-4}}{2} = 2.5 \times 10^{-9}$$

Thus, $2.5 \times 10^{-9} > 1.8 \times 10^{-10}$ (K_{sp})

6. (c) : $S_2O_4^{2-}$: 

7. (d): Br_2 reacts with hot and strong NaOH to give NaBr, $NaBrO_3$ and H_2O.

8. (a, b, c) : $r_n = r_1 \times n^2/Z$

$r_{2(H)} = r_{1(H)} \times 2^2 = 4r_{1(H)}$

$$r_{4(He^+)} = \frac{r_{1(H)} \times 4^2}{Z} = \frac{r_{1(H)} \times 4^2}{2} \quad \therefore \quad \frac{r_{2(H)}}{r_{4He^+}} = \frac{1}{2}$$

$$T = \frac{2\pi r}{nh} \times 2\pi rm = \frac{4\pi^2 mr^2}{nh}$$

$$T = \frac{n^3}{Z^2} T_{(H)} \qquad \left(\because r \propto \frac{n^2}{Z}\right)$$

$$T_{2(H)} = \frac{(2)^3}{(1)^2} T_{(H)} = 8T_{(H)}$$

$$T_{4(He^+)} = \frac{(4)^3}{(2)^2} T_{(H)} = 16\, T_{(H)}$$

$$\frac{T_{2(H)}}{T_{4(He^+)}} = \frac{1}{2}$$

No. of waves in an orbit = No. of orbit

$$\therefore \quad \frac{n_{2H}}{n_{4He^+}} = \frac{2}{4} = \frac{1}{2}$$

$$E_n = \frac{E_1}{n^2} \times Z^2 \quad \Rightarrow \quad E_{2(H)} = \frac{E_1}{4} \times 1^2$$

$$E_{4(He^+)} = \frac{E_1 \times 2^2}{4^2} \quad \therefore \quad \frac{E_{2(H)}}{E_{4(He^+)}} = 1$$

9. (a, c) : As ΔS does not depend on path and only depends on initial and final stages *i.e.*, it is a state function thus

$\Delta S_{X \to Z} = \Delta S_{X \to Y} + \Delta S_{Y \to Z}$

and $\Delta S_{Y \to Z}$ is not zero

Thus, $\Delta S_{X \to Y \to Z} \neq \Delta S_{X \to Y}$

As we know that work is not a state function and depends on path,

Thus, $w_{X \to Z} \neq w_{X \to Y} + w_{Y \to Z}$

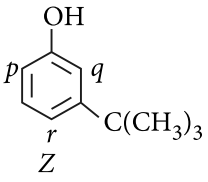
$w_{X \to Y} = PdV$ (P is constant.)

$w_{Y \to Z} = 0$ (V is constant.)

$w_{X \to Y \to Z} = w_{X \to Y} + w_{Y \to Z}$

As $w_{Y \to Z} = 0$, hence $w_{X \to Y \to Z} = w_{X \to Y}$

10. (a, b, c) :



p, q and r are suitable positions as per electronic effect of –OH group. Due to steric effect of the *tert*-butyl group, the bulky electrophiles are less likely to attack positions q and r. Hence, position p is suitable for I_2, positions p and r are suitable for Br_2 and Cl_2 being smaller can attack all p, q and r positions.

11. (a, d) : Cassiterite ore (SnO_2) :

$SnO_2 + C \longrightarrow SnO + CO$

$SnO + C \longrightarrow Sn + CO$ } carbon reduction

Also iron is present as impurity in the ore.

12. (a, b, c, d) : $\Delta G = \Delta G^\circ + 2.303\ RT \log Q$

$\Delta G^\circ = 2 \times G^\circ_{NO_2} - G^\circ_{N_2O_4} = 2 \times 50 - 100 = 0$

$$\therefore \quad \Delta G = 0 + 2.303 \times 8.314 \times 10^{-3} \times 298 \log \frac{2^2}{5}$$

$= 0 - 0.55$ kJ

$\therefore$ $\Delta G = -0.55$ kJ, *i.e.*, reaction proceeds in forward direction.

Also, $\Delta G^\circ = 0 = -2.303\ RT \log K_c \quad \therefore \quad K_c = 1$

Now, $N_2O_4 \rightleftharpoons 2NO_2$

$\underset{(5-x)}{5} \qquad \underset{(2+2x)}{2}$

$$\therefore \quad 1 = \frac{(2+2x)^2}{(5-x)} \quad \text{or} \quad x = 0.106$$

$[NO_2] = 2 + 2x = 2 + 2 \times 0.106 = 2.212$ M

$[N_2O_4] = (5 - x) = 5 - 0.106 = 4.894$ M

13. (d)

14. (a, c, d) :

$K_3[Fe(CN)_6] + I^- \longrightarrow K_4[Fe(CN)_6] + I_2$ (or I_3^-)

Brownish yellow solution

$\downarrow ZnSO_4$

$[Zn(OH)_4]^{2-}$ ← NaOH — $K_2Zn[Fe(CN)_6] + I_2$ (or I_3^-)

Soluble complex — White ppt.

$\downarrow Na_2S_2O_3$; $\downarrow$ Starch

$I^- + Na_2S_4O_6$ — Blue colour solution

Colourless solution

15. (a) :

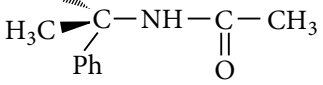
$CH_3-\underset{\underset{O}{\|}}{C}-H + H_2N-OH \xrightarrow{\Delta}$

$CH_3-\underset{\underset{O}{\|}}{C}-NH_2 \xleftarrow{H^+} CH_3-CH=N-OH$

(Q) (P) (Syn or anti form)

$\xrightarrow{Br_2/KOH} CH_3-NH_2$

16. (d): Shift is retentive therefore initial configuration will be maintained. Initially it is "*R*" and afterwards also it will be "*R*".



17. (c) : On increasing concentration of NH_3, the concentration of H^+ ion decreases.

$$E_{red} = E^\circ_{red} - \frac{0.0591}{n} \log[H^+] = 0 - \frac{0.0591}{1} \log 10^{-11}$$

$= -0.0591 \times (-11) = 0.65$

18. (d)

Scientist of the Month

Dorothy Mary Crowfoot Hodgkin

(12 May 1910 - 29 July 1994)

Early life and Education

Dorothy Mary Crowfoot was a British Chemist and she was born in Cairo, Egypt. In 1921, Dorothy entered Sir John Leman Grammar School in Beccles where she was one of two girls allowed to study chemistry.

Dorothy developed a passion for chemistry from a young age and her mother fostered her interest in all the sciences. She was further encouraged by the chemist A.K. Joseph, a family friend who also worked in Sudan.

At the age of 18, she started studying Chemistry at Somerville College, Oxford. In 1932, Dorothy was awarded a first-class honours degree at the University, the third woman to achieve this distinction.

It was when she was doing research for her Doctor of Philosophy at Newnham College, Cambridge, Hodgkin became aware of the potential of X-ray crystallography to determine the structure of proteins. She was working with Bernal on the technique's first application to the analysis of a biological substance, pepsin. The pepsin experiment is largely credited to Dorothy herself, but she always made it clear that it was Bernal who initially took the photographs and gave her additional key insights. Her PhD was awarded in 1937 for research on X-ray crystallography and the chemistry of the sterols.

Contributions

Dorothy was particularly noted for discovering three-dimensional biomolecular structures. In 1945, working with C. H. Carlisle, she published the first such structure of a steroid, cholesteryl iodide.

In 1948, Dorothy first encountered vitamin B_{12}, and created new crystals. Vitamin B_{12} had first been discovered by Merck earlier that year. It had a structure at the time that was almost completely unknown, and when Dorothy discovered it contained cobalt, she realized the structure actualisation could be determined by X-ray crystallography analysis.

The B_{12} study published by Hodgkin was described by Lawrence Bragg being significant "as breaking the sound barrier". The final structure of B_{12}, for which Dorothy was later awarded the Nobel Prize, was published in 1955.

Insulin was one of Dorothy's most extraordinary research projects. The hormone captured her imagination because of the intricate and wide-ranging effect it has in the body. However, at this stage X-ray crystallography had not been developed far enough to cope with the complexity of the insulin molecule. She and others spent many years improving the technique. Larger and more complex molecules were tackled until in 1969 (35 years later) the structure of insulin was finally resolved.

Awards & Honours

- Dorothy won the 1964 Nobel Prize in Chemistry and as of 2016 remains the only British woman scientist to have been awarded a Nobel Prize in any of the three sciences it recognises.
- In 1965, she was the second woman in 60 years, after Florence Nightingale, to be appointed to the order of Merit by a king or queen.
- Elected a Fellow of the Royal Society (FRS) in 1947 and EMBO Membership in 1970. Dorothy was Chancellor of the University of Bristol from 1970 to 1988. In 1958, she was elected a Foreign Honorary Member of the American Academy of Arts and Sciences.
- She became a foreign member of the USSR Academy of Sciences in the 1970s. In 1982, Dorothy received the Lomonosov Medal of the Soviet Academy of Sciences and in 1987 she accepted the Lenin Peace Prize from the government of Mikhail Gorbachev.
- The Royal Society awards the Dorothy Hodgkin Fellowship (named in her honour) "for outstanding scientists at an early stage of their research career who require a flexible working pattern due to personal circumstances, such as parenting or caring responsibilities or health-related reasons".

PUZZLE CORNER

SOLUTION - APRIL 2018

1	3	2	4	5
4	5	1	2	3
3	4	5	1	2
5	2	4	3	1
2	1	3	5	4

(a) Carbon (6)
(b) Chromium (24)
(c) Mercury (80)
(d) Neon (10)
(e) Phosphorus (15)
(f) Neodymium (60)
(g) Helium (2)
(h) Lithium (3)

Solution Senders of Chemistry Musing

Set - 57

- Praveen T. Reddy, Telangana
- Vinita Bhargva, New Delhi

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- Arshath Jamal, Tamil Nadu
- Prosanta Pal, West Bengal

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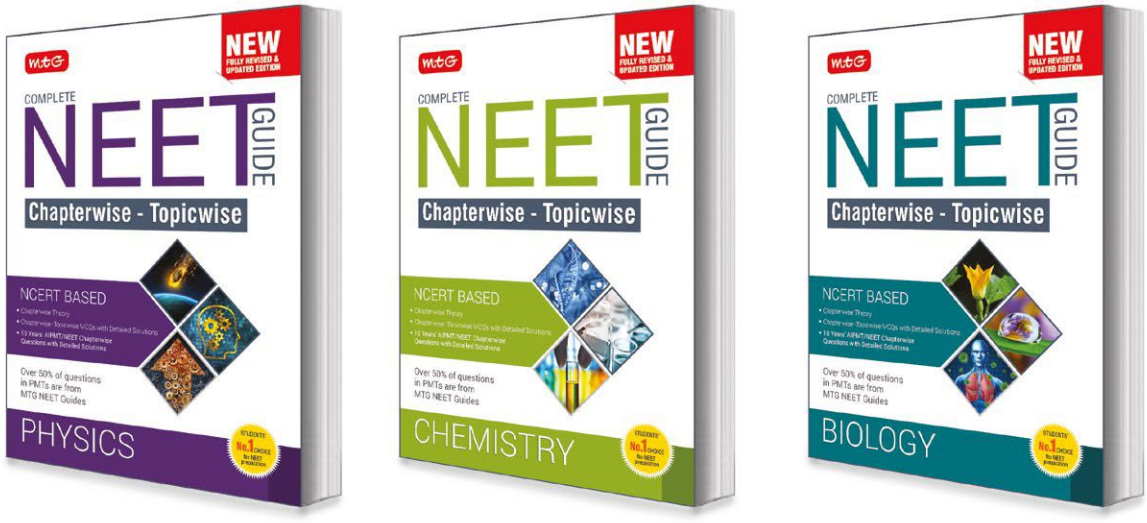

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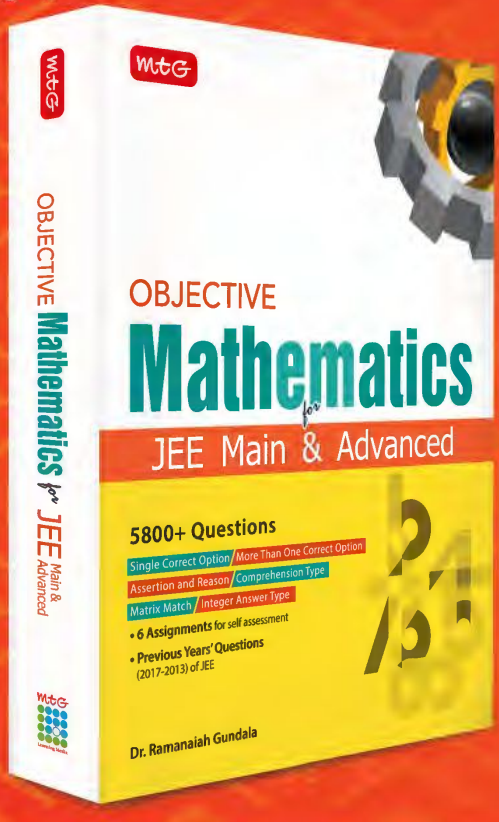

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